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An Irrigation Project on a Normally Dry River, Presidio County, Texas.

By W. W. COLPITTS,* M. Am. Soc. C. E.

The St. Stephen Land and Irrigation Company's project, located 11 miles south of Marfa, the county seat of Presidio County, Texas, is unusual to the extent that it depends solely on flood water for its source of supply, the stream on which its dam and reservoir are located being dry the greater part of the time. Because of this fact and the possibilities of a wide extension in its immediate neighborhood of the principles upon which its success depends, much public interest in the project has been aroused. So far as the writer is aware, it is the first attempt of the kind in western Texas to conserve the flood waters of dry streams in a region of light rainfall for application by gravity to the small but extremely fertile valleys of that section, and as such presents some features of interest.

The streams in the drainage area converge to a narrow rocky canyon about 3,000 ft. in length, immediately below which is the land to be irrigated. Above the entrance to the canyon is a wide, deep basin in which a much larger volume of water may be impounded than necessary to irrigate the land in the valley below. The dam is constructed at the upper end of the canyon at its narrowest point.

Rainfall and Runoff.

The Government rainfall records of the Ft. Davis observatory (located at about the average altitude of the St. Stephen project's drainage area, and about eight miles from it) cover a period of about 55 years and show an average annual rainfall of 17.46 ins., distributed monthly as follows:

January	0.54	August	3.59
February	0.50	September	2.95
March	0.39	October	1.34
April	0.54	November	0.60
May	1.04	December	0.58
June	1.95	Annual	17.46
July	3.47		

It will be observed that the greatest precipitation occurs during the growing season, a feature of considerable importance as affecting the necessary storage capacity of the reservoir and the consideration to be given the subject of evaporation.

While no accurate record of the percentage of runoff of this region is obtainable, some rough calculations, based on observations of the flow of the stream shortly after rainfalls, were made both before and after development work was begun. Each season during the recent unprecedented drouth, rainfalls have occurred in the mountains on the outer rim of the drainage area, that caused the stream in the canyon to flow strongly, despite the fact that for about three years practically no rain has fallen on the plains below, which comprise a large percentage of the drainage area.

Since construction work on the dam began, several ordinary rainfalls have occurred. A section of the uncompleted dam was several times overflowed, and this section forming a weir, readily permitted the making of accurate calculations of the amount of water passed.

From the results of these observations and considering the character of the drainage area, it is estimated that the average runoff is about 20% of the rainfall, giving an average annual runoff from the whole drainage area of about 74,000 acre-ft. Thunder storms occur regularly each year in the mountains, from which the runoff percentage is undoubtedly much greater.

Drainage Area.

The drainage area is about 500 square miles, and is composed largely of rolling plains at an average elevation of about 4,800 ft. above sea level, and having an average slope of about 100 ft. to the mile.

The drainage area is bounded on the outer rim by the Davis Mountains, rising to a height of about 8,000 ft. The soil of the plains is very thin and hard and is covered with short grass. The mountains are of igneous rock and are very precipitous. The country is devoted exclusively to stock raising.

The silt carried by the streams emptying into the reservoir basin is very heavy in character and although, during extreme floods, the amount of silt carried by these streams is large, because of the very considerable slope of the drainage area, it has been observed that it settles quickly and will probably be deposited toward the mouths of the streams rather than at the dam. To provide against any danger of overloading the dam from this cause, however, the sections were enlarged toward the bottom.

Irrigable Land.

The irrigable land, comprising about 9,000 acres, lies in the valley of Alamito Creek, beginning within about 3,000 ft. of the dam site, and has an average elevation of 4,300 ft. The valley is a uniform plane, about two miles in width and eight miles long, and slopes toward the south at the rate of about 25 ft. to the mile. The sides of the valley are bounded by sheer walls about 200 ft. high, which, with the mountains in the distance, presents a most picturesque scene. The

IRRIGATION DAM AND RESERVOIR ON ALAMITO CREEK, TEXAS.
(Creek is dry 95% of the year.)

*Chief Engineer, Kansas City, Missouri & Orient Ry., Kansas City, Mo.

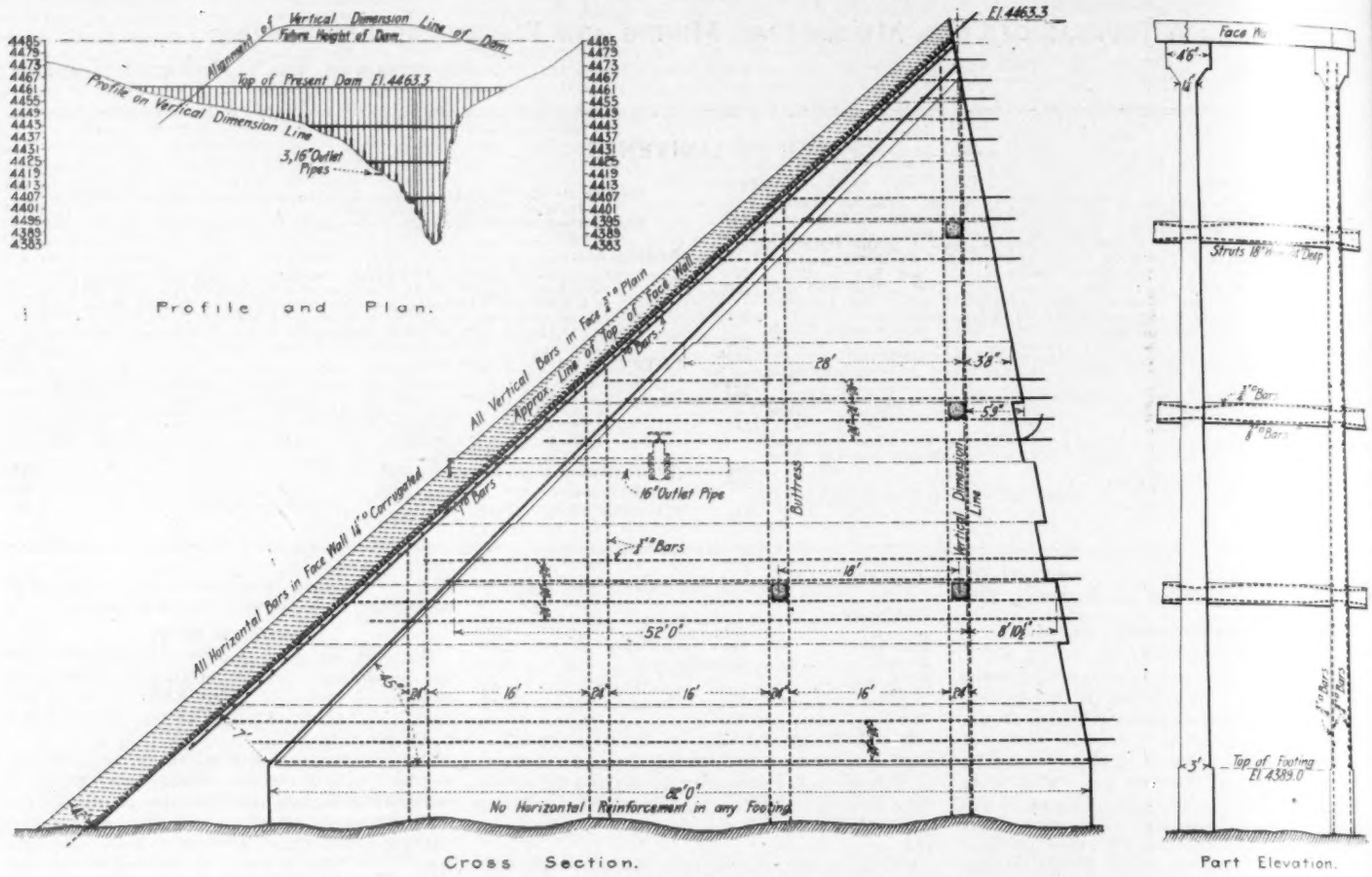

FIG. 2. DETAILS OF HOLLOW CONCRETE DAM ACROSS ALAMITO CREEK, TEXAS.
(Note recesses for bonding new part of buttress to old when dam is enlarged.)

climate is similar to that of eastern Colorado and is ideal for farming. The soil is a thick chocolate loam and produces abundantly fruits, vegetables and cereals of all kinds.

The Southern Pacific Railway's main New Orleans-San Francisco line is within 11 miles of the project, and the valley will be traversed throughout by the Kansas City, Mexico & Orient Ry., now under construction in the immediate vicinity.

Dam.

The dam site is a narrow rocky gorge of solid homogeneous rock throughout, without faults or fissures of any kind. The dam is the Ambursen type and was designed by the writer, as shown in the accompanying figures. It is built to permit of raising it at a future date to Elev. 4485, should the necessity arise, and with that in view, the horizontal bars in the buttresses extend 3 ft. beyond the rear, to aid in bonding the new concrete of the extension to the old. The face wall is of 1:2:4 concrete, trenched 3 ft. into the rock, reinforced with 1¼-in. round, corrugated, high elastic limit bars. The sections were designed under working stresses recommended by the American Railway Engineering Association. Shearing and diagonal stresses are resisted by bending up the ends of the horizontal bars rather than by stirrups, because of the greater convenience of placing the former. The horizontal bars were bent cold, with a bending machine, and accurately spaced by means of patent spacers.

The buttresses are of 1:3:5 concrete, put up in lifts of 6 ft., the upper surface of each lift being notched to resist longitudinal shear. The buttresses are also trenched into the rock. Suitable sand and gravel for concrete were available in the immediate vicinity of the dam site.

The whole structure was designed with a view of uniformity in forming, and except that the form sections were found to be somewhat heavy and difficult to move in the upper lifts, they were very satisfactory. The work was done by company forces entirely, under the direct supervision of Mr. E. D. Cruise, Resident Engineer.

Canals and Laterals.

The main canal, for a distance of half a mile, is in rock and passes through a tunnel 700 ft. long at the extremity of this section. Beyond the tunnel, the canal divides into two arms, one following each side of the valley. From each of the main canals, laterals are taken out, which convey water directly to the tracts to be irrigated. The laterals cross the east and west subdivision

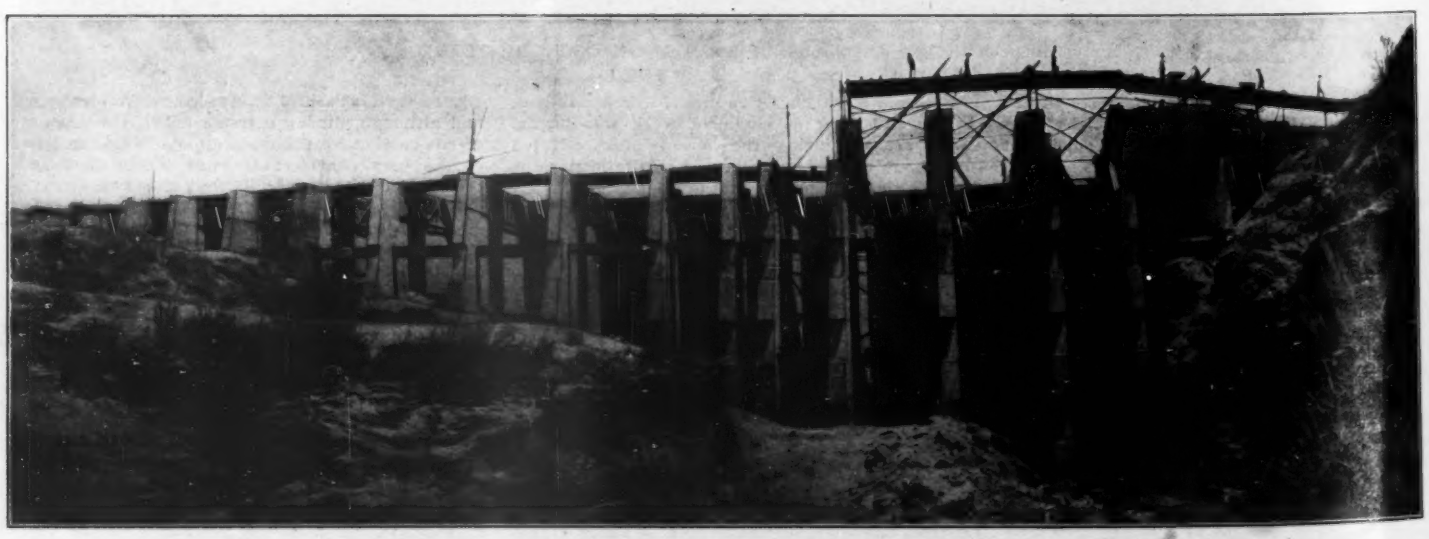

FIG. 3. VIEW OF REAR OF DAM DURING CONSTRUCTION.

lines of square mile sections approximately at right angles, the contour of the valley being such as to permit of running the laterals in straight lines for considerable distances. The upper sides of the laterals are the boundary lines of the tracts, so that all parts of a tract will be subject to irrigation.

The main canals are 9 ft. wide on the bottom and have a slope of 2.5 ft. per mile. The laterals

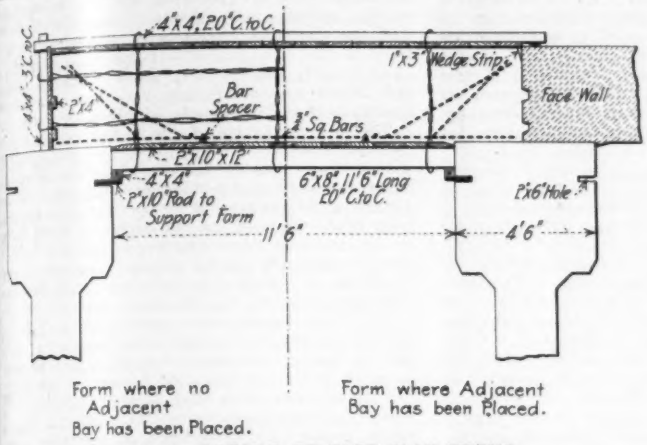

FIG. 4. DETAILS OF FACE SLAB FORMS.

are generally 3 ft. wide on the bottom, with a slope of 6 ft. to the mile. To maintain these slopes, drops are occasionally necessary, and on the main canals the drops are made in the rock of the hillside.

Another Oil-Fuel Gas Producer is reported from Los Angeles, Cal. According to press reports this apparatus has been designed by Messrs. F. C. Nelles and H. A. Grine. An experimental unit was used with a 100-H.P. gas engine in the pumping plant of W. C. Fry in the Hollywood district, continuously during June and July. While no adequate figures of power production are available, it is reported that the quantity of crude oil used was only three quarters that of the distillate (low-grade gasoline) formerly required for the same length of time. The oil is sprayed in through a "burner" in the top of a furnace and passes down through a bed of incandescent carbon to fix the volatile constituents. From here the gas passes up a tower containing stones over which water is sprayed. No other coolers or scrubbers are necessary it is claimed.

The Chicago Great Western R. R. Co. under date of Aug. 1, 1911, issued to "each and every conductor, brakeman, engineer, fireman, agent, clerk," etc., etc., the following preachment on conservation:

"A penny saved is a penny earned," applies to individuals and corporations alike. The opportunity of a personal inspection of our railroad housekeeping during the past few weeks has convinced me that we must begin, and at once, to earn by saving.

Thousands of dollars worth of property, belonging to the company, is lying useless for want of a little care, and a trifling outlay for repairs.

One illustration will suffice: Twelve dozen hand lamps were collected, which when sent to the General Storekeeper's Department, were found to need possibly an average of five cents' worth of repairs to make them again as good as new. It will not be necessary to replace them with new lamps.

In ten days, four carloads of surplus material were reclaimed.

It is my personal request that every employe join with me in this conservation movement.

Make it a personal matter to make a systematic inspection of all material on hand—tools, stationery forms, empty ink bottles, etc. Anything that is of no immediate use in your department, tag and send to the General Storekeeper, or deliver to the supply car when it reaches your station, with exception of stationery and ink bottles which are to be sent to the Stationery Storekeeper at Chicago.

"Scrap" should be picked up and assembled at some central point, where it can be conveniently and cheaply loaded for disposal.

"Tools" when worn out have a certain value, and should be turned in.

True economy is not parsimony, and when by our individual efforts each employe aids in thus "picking up" the company's money, as he would if he saw a penny, a nickel, a dime or a dollar in his way, we are sure there will be a good showing of dollars saved by our knowledge and practice of the principles of Conservation.

A rational interest in the valuation of the Company's property may be aroused by consulting the list of prices and values shown on pages 3, 3 and 4 of this circular [not reproduced here; gives new, second-hand and scrap values].

Municipal Engineering as a Profession.*

By B. WYAND.†

There no longer exists the need to drive home the fact that municipal engineering is a distinct profession. There was a time when the statement would have been met with a shrug of the shoulder or a curl of the lip. To-day no dispute is possible. The profession is recognized universally, and its separate existence is proved in that the Legislature is the one notable exception that has not yet awakened to the fact that this very lusty infant is among us and is making vigorous outcry for its rights. The pedigree of this interesting infant is lost in obscurity. Road foremen, inspectors of nuisances, village grocers, ex-policemen, drapers and civil engineers of the old school are among its progenitors, and it is possible that each of these crossings has had its healthy influence upon the matured product.

THE CONSULTING ENGINEER.—Municipal engineering is a profession which will some day be found to have usurped the whole field of engineering, except that form known as Government engineering. The consultant will, I am afraid, have a very bad time; but the inevitable has to be faced. As matters are now, the municipal man is not encouraged to prepare schemes of any magnitude, and many who are really capable—there are, of course, quite as many (if not more) who are not capable—conceal their knowledge. There is always trouble about payment where the salaried officer is concerned, and when a fee is arranged it is usually only a proportion of that which the consultant would be paid. Honorariums are merely a means to an end—the end being the payment of an amount equal to about one-tenth of that which is morally due. To come back to my point, however. In every direction now municipal trading is being extended. Municipal schemes to run means more responsibility for the officer, and the necessity for a better class of officer—a more highly-trained and more intelligent man. This, again, means higher salary, larger staff, and better accommodation, together with the less frequent requisitioning of the consultant. It may be urged that never was the consultant so in evidence as during the last few years. It is quite true, but it has to be remembered that he is largely engaged in installing first schemes. Extension will not, in scores of cases, go to him; for the necessity for a highly-trained man to run a concern does away with the necessity for another highly-trained man to repeat, to improve or to extend what has already been done.

IMPROVING THE STATUS.—There has been much talk of late about improving the status of the profession. The term is a misleading one. What is wanted is to improve the status of the members of the profession, and every man who realizes that he is an adviser, and not a servant, is working on right lines. Municipal engineers must realize their own importance. I do not mean that they should cultivate deep voices and contort themselves into ponderous attitudes. I mean only that they must feel their responsibilities, and recognize the fact that supremacy is their place in local life. Even the chairman of the council is merely a cipher when contrasted with the municipal engineer, and he should, as far as possible, be made to feel this. The chairman may be the better man in many ways; but when it comes to engineering he should be made to recognize the fact that he must play fourth fiddle, and must feel happy that he has not been relegated to the orchestral triangle. A man is estimated in this world much at the value he places upon himself, and the humble, shrinking individual who is led by his council is never likely to command either respect or a periodical increase of salary. The blatant gentleman who boasts freely is much more likely to succeed for a time; but his day is not usually a long one, and he is the last man to make capital out of a reverse of fortune.

SECURITY OF TENURE.—I will say nothing harsher of councillors than that they are entirely unnecessary, and I am sadly afraid that security of tenure will be difficult of attainment so long as district councils exist. It is not to be expected—it would be foreign to human nature—that councillors would welcome the continued services of a man with whom they had quarreled and of whose services they had endeavored to rid themselves. The life of the officer would be a miniature hell; indeed, things would be made so unpleasant for him that he would welcome resignation.

The sole duty of the council should be the making of the rate, and this could be as well done by one man as by 20—the collector could, in fact, do it. Directly a council concerns itself on engineering matters it becomes ridiculous, and the effect of its interference is to hamper the technical officers. These should be appointed by a central controlling authority, and should be removable only for misconduct, or at an age when a pension (and a sufficient one) falls due. Their appointment would, in fact, be a life one, with promotion to larger appointments as vacancies occur. They would be responsible to the central department only, just as are police and post-office officials. What would happen were these classes appointed and dismissed at the pleasure of small local bodies? Perhaps, when councils no longer exist, the municipal engineer will be appreciated at his true worth. Until then but little can, I fear, be done.

SALARIES.—The question of salaries is all-important. Municipal engineers are usually woefully underpaid and overworked. Higher salaries and less hours of labor would reduce the ranks of the unemployed, and the overcrowding question would not recur for years. There would be room for thousands if proper and sufficient staffs were engaged. £150 [$750] a year should be the minimum salary for even a deputy or chief assistant.

QUALIFICATIONS.—The full qualifications for a municipal engineering appointment are so many and so varied that no one man could satisfy a standard. The essential qualifications would place no light tax on a man's abilities, and none should be appointed without these. Some towns have, I believe, passed resolutions to the effect that no man should be appointed who has not passed the examination of the Institution of Civil Engineers, qualifying for at least associate membership. This is, of course, pure nonsense; indeed, so far as municipal engineering goes, the examination is three-fourths sheer waste of time. While there are special examinations for municipal engineers, it is as ridiculous to ask a man to pass another as it would be to ask a judge to pass in surgery because he might on some occasion have to hear an action in which a broken leg was introduced. That some limitation should be imposed upon the appointment of quite unqualified men no one will deny, but it is equally important that the test to be undergone shall be a reasonable one. It is to be hoped that councillors will not allow themselves longer or to any further extent to be hoodwinked by men whose interest is with an alien profession. It must not be forgotten either—and I cannot lay too great a stress upon it—that civil engineering as practised is only one branch of municipal engineering. A calculating boy or similar wonder need not necessarily make a good municipal engineer.

I have no hesitation, in conclusion, in placing municipal engineering at the top of all the professions. It is one in which the duffer can never shine, and there is no other profession of which this can be said, except perhaps that of the barrister, and he, unless possessed of special talent, has no chance unless he be promoted to the bench. The time has arrived when the municipal engineer must take the place which is his by right, and with two active bodies [associations] to voice his interests, both working now upon similar lines, great strides must inevitably be made during the next decade or two. Individual effort is, however, none the less necessary.

*Portions of a paper read before the Institution of Municipal Engineers, Western District, Worcester, England, on July 15, 1911.

†Secretary, Institution of Municipal Engineers.

The New Vienna Industrial Museum, founded two years ago as a memorial of the emperor's 60th anniversary, solicits contributions of tools, apparatus, instruments, models, books, etc., for its historical collections. Thirteen sections have been formed, ranging from mining and metallurgy to woodwork and musical instruments. The museum building is nearing completion, but donations are being stored and arranged in space put at the disposal of the museum by the Austrian government. The office of the museum is at Ebendorferstrasse 6, Vienna I. The Director is L. Erhard, and the secretary is A. Klima.

The Significance of Flora and Fauna in Maintaining the Purity of Natural Waters, and How They Are Affected by Domestic Sewage and Industrial Wastes.

Translated from the German by EMIL KUICHLING,* M. Am. Soc. C. E.

[This fascinating epitome of the important role played by the aquatic flora and fauna in maintaining the purity of streams and lakes was written by the late Dr. Maximilian Marsson in December, 1909, as the latest revision of a lecture which he had frequently delivered before the Royal Testing Station for Water-Supply and Sewage Disposal at Berlin, Germany, with which station Dr. Marsson was connected at the time of his death. The lecture as here translated originally appeared in "Mitteilungen aus der Königlichen Prüfungsanstalt für Wasserversorgung und Abwasserbeseitigung," Heft 14, 1911, having been prepared for publication by Dr. Marsson's associate, Prof. R. Kolkwitz.

Dealing as the lecture does with natural phenomena of universal extent and of economic as well as hygienic importance, the paper promises to appeal to a far larger class of readers than might appear at first thought from its title. The reader who is unfamiliar with the forms of life which are mentioned so frequently throughout the article should not leave the article unread on that account, for while the article will have greater significance to those thoroughly acquainted with the flora and fauna of water it will be found that its main teachings are plain without such knowledge.

The article abounds with suggestions to the sanitary engineer, chemist and bacteriologist, as well as to laymen interested in maintaining the purity of rivers and lakes. Many of the facts and suggestions presented by the author have a practical bearing on sewage disposal by dilution and give emphasis to the great possibilities of that method of getting rid of the organic wastes of cities when the method is employed in the light of scientific knowledge.

Particular attention may well be directed to the remarks on trades wastes in the latter part of the lecture. These remarks show that many of the agitators for the prevention of water pollution would do well to direct more attention to the evils of industrial wastes and less to domestic sewage. It is important for all to take into account the relationship between organic wastes in natural waters and the maintenance and increase of that fish life which is so important to mankind, both economically and as a means of one of the most wholesome forms of outdoor recreation.

Coming now to a matter of typography, we assume responsibility for the center and side heads which we have introduced for the possible aid of the reader. It seems only fair for us to mention this in view of the possibility that some of these may appear to give a different shade of meaning to the lecture than what was originally intended by the author, even though the translator has kindly given our additions careful attention.

Finally, it seems fitting to commend the smoothness of the translation made by Mr. Kuichling and to call particular attention to the list of writings of Dr. Marsson, which list not only gives some indication of the range of the author's work, but may be useful to those who wish to pursue this subject further, and are fortunate enough to be able to do so in the German.—Ed.]

In 1867 the Danish naturalist, Peter Erasmus Müller, while on a visit to Switzerland, first noticed that the waters of the Swiss lakes were teeming with small crustacea. Previously it had been considered that these clear waters contained no living organisms, and the confirmation of Müller's observations by the examination of bodies of water in other parts of Europe caused much astonishment. These investigations revealed not only minute crustacea, but also enormous numbers of rotifera and protozoa, thus showing that these animalcules were cosmopolitan in their distribution. The detailed study of these organisms in Lake Leman was first undertaken about 1870 by the Swiss naturalist, F. A. Forel, and soon after 1880 other Swiss lakes were examined by Asper, Heuscher and Imhoff. They found that the microscopic organisms spent their lives swimming in the water, and that many low forms of plant-life were associated with these small animals. This is true of the ocean, as well as of bodies of fresh water. The marine investigations were undertaken by Dr. V. Hensen, of Kiel, in order to study the transformation of matter in sea water, and in 1887 he published his important work on "The Determination of the Plankton, or the Animal and Vegetable Matter drifting about in the Sea." The appearance of this book marks a new epoch in hydrobiology, and particularly in respect to quantitative investigation.

*Consulting Engineer, 52 Broadway, New York City.

The Plankton.

By the term "plankton" Hensen meant "everything that drifts about in water," but it is preferable to define the word as embracing "all LIVING MATTER that drifts involuntarily," as drifting dead matter is now called "pseudo-plankton." The plankton thus includes all living organisms drifting about or remaining suspended in the water between surface and bottom, but without ever coming in contact with the latter; and its distribution depends mainly on winds and currents, being affected only in slight degree by the locomotive powers of the organisms themselves. In addition to suitable adaptations for nourishment, propagation and protection against foes, as usually found in the animal world, this large living community also requires the further peculiarity of organization which enables the individuals to remain suspended in the water without appreciable effort on their part. The quantitative investigation of fresh-water plankton was advanced greatly by C. Apstein, a pupil of Hensen, who published in 1896 a comprehensive treatise on the subject.

The study of fresh-water and marine plankton is now carried on at biological stations in many places on the earth's surface. Austria has such a station which was established in 1888 by Prof. Fritsch of Prague at the Unternitzer Pond, and Germany has one that was established in 1891 by Prof. Otto Zacharias at Great Plöner Lake. For practical pisciculture, biological experiment stations have been located at Müggel Lake and Trachenberg. The advantage of such stations consists in the possibility of studying systematically all conditions of aquatic life in every season, kind of weather and mode of illumination, and also of utilizing to the fullest extent many more observations afforded by constant proximity to the water than could be gained by occasional visits.

In the following pages it is my purpose to consider in somewhat greater detail the various groups of hydrophytes and hydrozoa, and especially their relations to the self-purification of water. The other factors of self-purification, such as the chemical and physical or mechanical agencies, will not be considered here. I have called attention particularly to the plankton, because its vegetable component is the fundamental food supply or condition of existence for all aquatic life. It comes from the products of the decomposition of the albumen which finds its way into the water from decaying animals and plants as well as from sewage. The self-purifying power of natural waters is merely the maintenance of the proper equilibrium between retrogressive and progressive metamorphosis, and frequent reference thereto will be made in the following.

In discriminating between vegetable and animal plankton, also taking into account the remaining aquatic organisms that are found on the bottom and shores, we find that we must divide them into two classes, viz: Food Producers and Food Consumers. The plants which assimilate inorganic matter and build up organic compounds by means of their chromophyll coloring matter, belong to the first class; and all other organisms, such as microscopic protozoa, rotifera, etc., together with the larger ones up to the fishes, belong to the second class, or food consumers.

Vegetable Plankton: Food Producers.

Let us now consider the Plants somewhat more closely. In waters the algae play the most important part, as they exhibit the greatest diversity of form. They are found in all places where water has collected, even in long-stagnant rain water, but their vegetation varies with the seasons and the character of the water. While the plankton contains many uni-cellular forms and coherent colonies, or strings of such, we find in shallow waters, streams and shores mostly the confervae, or thread-like algae, which appear as thick mats or strands of light or dark green color. The blue-green group called schizophyceae is also widely distributed, and representatives thereof usually produce the so-called "blooming" of our rivers and lakes, while others, especially the oscillatoria, often settle in strongly polluted waters, such as the gutters and ditches of unsewered towns and the drainage channels of barnyards. When they form a covering of wet and polluted ground, they usually have a deep black color, but similar kinds are sometimes red, and have been mistaken for dried pools of blood.

The other groups of algae have only a few representatives in fresh water. Of these the diatoms and bacillariaceae have been most extensively studied by microscopists, as they are found in all seasons in every water course and pool from the pole to the equator, and as well in icy streams from glaciers as in hot springs. They sometimes appear in such enormous quantities as to render a counting of individuals impracticable. It was formerly believed that in winter our frozen rivers and lakes were devoid of life, as the water was then unusually clear; but on closer examination by filtering the water through a net of fine silk gauze, or by killing the living organisms with alcohol, formalin, etc., and concentrating them by sedimentation or other means, an abundance of microscopic organisms of various kinds, and especially diatoms, will be found in all seasons. The cell body of these algae is held together by a silicious skeleton, which has often so delicate a structure as to be defined clearly only by the best microscopes; and hence certain species of diatoms, such as Surirella Gemma and Pleurosigma Angulatum, are used as test objects for the best objectives. Through their brown coloring matter, called diatomin, these silicious algae are as capable of assimilating organic matter as are the green and blue-green algae by means of their normal green coloring matter called chlorophyll.

As the assimilative activity of the algae is a very important factor in maintaining the purity of our streams, it is necessary for us to consider briefly the structure of the microscopic plant cells, of which the higher plants are composed.

In opposition to the animal cell, a well-defined vegetable cell is enclosed by a dense skin, called the membrane. For this reason the cells of a plant are sharply separated from each other. Each such cell possesses a much greater independence than the cells of the body of an animal, or at least of the higher developed animals. In almost every plant cell there is a nucleus, the remainder of the volume being filled by the cell plasm or cytoplasm, which is rich in albuminous substances, and in which the carriers of coloring matter, or the chromatophores, are distributed. These three components (nucleus, cytoplasm and chromatophores) taken together are commonly called protoplasm, or more briefly plasm, which includes all the living constituents or protoplasts of the cell. The chief function of the cell is based upon a reciprocal action between the nucleus and the plasm. The chromatophores or chloroplasts, however, whose predominant green coloring matter is chlorophyll, exercise an important function in the cell, since with the help of the vibrations of light they are enabled to dissociate carbon from the carbonic acid that is contained in air and water, and to prepare with the elements of water organic matter having little oxygen. Polymeric carbonaceous products are thus formed which then develop into starch and certain kinds of sugar; and these compounds, in conjunction with the simplest combination of nitrogen, finally serve to form albumen and other complex combinations for the use of plants, whereby the weight of dry organic matter in the latter is increased. The nitrogen required to form the albuminous compounds is obtained from ammonia and nitrates, and other elements found in the ground and water also appear to play a not less important part in the formation of albumen.

ASSIMILATION.—This entire synthetic process, in which oxygen is dissociated from carbonic acid in the form of gas, is called Assimilation. It is the same in land plants as in aquatic plants. In the case of the latter, the highly developed as well as the microscopically small, the necessary supply of carbonic acid is derived only from the surrounding water. In the diatoms the starch is replaced by a fatty oil, which develops more abundantly in the species that grow upon the bottom than in the seamless

species which live freely suspended in the water, and usually constitute the greater part of the plankton of sluggish streams. After the winter's cold has passed away and the heat rays of the sun are able to penetrate deeply into the water, however, the microscopic plants which have been dormant on the bottom are stimulated to renewed activity and multiply with amazing rapidity, whereupon they are lifted upward by the assimilation gases and appear on the surface of the water. In March, April and May, thick brown masses are seen floating in our rivers, and are commonly regarded as filthy or disgusting matter; but on examining a small portion thereof under a microscope, it will be found to consist of amorphous earthy and dead organic matter intermixed with bubbles of gas and swaying tangles of blue-green filaments called Oscillatoria, among which countless diatoms may be seen gliding to and fro. Both of these varieties of algaé possess a remarkable power of motion, which renders it possible for them to crawl about on the bottom or to move in the sludge on the bed.

The seamless diatoms of the plankton do not require this ability to move about, as they are held in suspension by their peculiar shape; but the species that live on the bottom have a seam at which pulsations of plasm that produce motion are manifested. It is very interesting to observe how a parallelism has developed between the biological relations and the morphological structure of an organism. The algae which are lifted from the bottom by gas bubbles and are not normal constituents of the plankton, are scattered about in running water and purify it by removing therefrom the carbonic acid which has accumulated during the winter. This is done by dissociating the oxygen from the acid and letting the former aerate the water. Such indirectly anti-putrefactive organisms generally develop in places where they are most needed, as in localities where the bottom consists of organic sludge or detritus of every kind instead of clean sand.

The production of oxygen, however, is not limited to the activity of the minute plants mentioned, but is maintained by all the other plants which are found in the streams throughout the entire year, even under the ice in winter, although in reduced numbers. As is to be expected, the assimilation gases act very energetically, especially in their nascent state, in oxidizing dissolved organic matter, and atmospheric oxygen is by no means so efficient. The plant life of a stream is therefore of the utmost importance, while the sun must be regarded as the source of the energy required for the development and growth of all these organisms.*

SUMMER AND WINTER EFFECTS.—Another significant factor must also be mentioned. In the examination of the plankton of small bodies of water, it was noticed that as many organisms of different kinds were found in winter as in summer. The algae that were held in suspension in the water and constituted the phytoplankton, seemed to thrive as well during the short daylight of winter as in summer, and thus maintained a similar constancy of the zooplankton. The variation of the temperature, therefore, had no effect, and the only other difference was in the mode of nutrition. It had previously been found that in addition to the matter obtained by assimilation, diatoms could absorb albuminous or similar nitrogenous compounds from the medium surrounding them, and hence that they derive their food from two distinct sources. Subsequent physiological experiments showed that diatoms as well as green algae can not only absorb carbon compounds from dissolved organic matter, but also organic nitrogen; and that when carbonic acid is rigidly excluded from the water they can digest diluted volatile fatty acids, amido-acids, skatol, urea, peptone, and other substances. Quite recently it was proved that certain diatoms, especially some of the marine varieties, were entirely devoid of chromophyll, or the coloring matter required for assimilation; that they subsisted exclusively on the products of decomposition derived from their surroundings, without recourse to assimilation; and hence that they needed only a medium containing a sufficient supply of food of various kinds. Such algae have accordingly become true saprophytes, or residents of putrefying matter, and by giving up their chromophyll they have taken the last step from a mixotropic to a heterotropic nourishment.

This direct absorption of dissolved organic matter by algae is of the utmost importance for the purification of streams by eliminating therefrom the soluble products of putrefaction. As all the algae that are held in suspension in the water of a river, as well as those that are lodged on the bed and shores, are busily engaged day and night in the work of producing fresh albumen, starch, and indirectly fats, from animal and vegetable refuse matter, it follows naturally that numerous animal organisms will develop in the water to make use of these products and convert them into living flesh.

Through these various investigations and the cyclical transformation of matter, it has become possible to understand how a constant biological self-purification takes place in our streams and lakes, even during the winter and under the ice, and that the maintenance of the plant life insures the continuation of the animal life in the water.

MOULDS OR FUNGI.—A similar mode of nourishment is exhibited by the Moulds or Fungi. These plants cannot assimilate inorganic matter, like those having chlorophyll, but must rely for their food on the presence of other organisms or of suitably prepared organic matter. They represent the realm of darkness and received the penalty which Nature has placed on the giving up of independent nutrition; they are either parasites or saprophytes, that is to say, they subsist on the products of the decomposition of dead organisms and vegetable and animal refuse matter, such as is contained in the sewage of cities and the wastes of factories.

BACTERIA.—The first of these organisms to appear in the water after the entrance of putrefying matter into a stream, are the Bacteria (Schizomycetes). They multiply most rapidly where they find the most food, but they also consume oxygen. The more extensive the bacterial processes, the greater will be the consumption of oxygen, and the more unfavorable will become the conditions for the existence of animal life which is dependent on the presence of oxygen in the water. By the removal of the oxygen the respiration of most living organisms is stopped, and they are thus deprived of that source of energy which is essential to the performance of their functions. If the green algae did not counteract the bacterial consumption of oxygen by constantly producing a new supply of this gas, our rivers would soon become completely poisoned and fouled by the continuous discharge of putrescible matter into them, as is now done by our large communities. The fact is, however, that a large proportion of the microbes in the sewage of our cities dies naturally soon after reaching the rivers.

The bacteria must not be regarded as enemies exclusively, as they are a necessary factor in all processes of decomposition that take place not only in water, but also in the whole economy of Nature. Their most important function is to liquefy the organic components of dead vegetable and animal matter, and render them capable of being absorbed by living plants. They decompose proteids, or albuminous substances, by abstracting therefrom ammonia, which is then oxidized to nitrous and nitric acid by certain nitrifying organisms. In this manner the decomposed organic raw material begins anew its course in the circulation of matter. For the formation of new food the soluble compounds of nitrogen, such as salts of ammonia, nitrites and nitrates, are of primary importance, and next come phosphates, silicates and other salts.

The magnitude, and eventually the cessation, of this new production of food is governed by Liebig's law of the minimum, according to which the energy of vegetation is limited by the energy of the least quantity of indispensable food material that is present. As soon as this is used up, further life comes to a standstill.

In the action of bacteria upon the dissolved nitrogenous matter that reaches the streams, a difference occurs in different seasons. The decomposition of putrescible material proceeds much more actively and quickly in the warm season, while in winter the phytoplankton and the filamentous fungi of the water consume a large proportion of this material by their peculiar mode of nutrition; but at higher temperatures the nitrites and nitrates resulting from the mineralizing processes that take place in the water are decomposed by the separation of free nitrogen therefrom. This decomposition is effected by Denitrifying Bacteria, which often require a relatively high maximum of temperature. By their activity in the warm season, when the processes of decomposition are most energetic, the poisoning of the water by inorganic compounds of nitrogen is prevented. The free nitrogen, however, cannot be utilized in appreciable degree for the structure of aquatic plants, and it is accordingly lost in the circulation of matter in water.

The orderly relations between the conditions of production and the actual production are determined to a large extent by the despised bacteria. Brandt has formulated some important considerations in this direction in his study of the circulation of matter in the sea; and it appears therefrom that the disturbing activity of the denitrifying bacteria is associated with the remarkable fact that the magnitude of production in the oceans of the arctic and temperate zones is not inferior to that of the tropical seas. This is directly contrary to the activity of land organisms, which exhibits a large decrease in production in proceeding from the tropics toward the poles. In the warm seas a relatively smaller production can take place, in spite of much more favorable conditions, in consequence of the greater decomposition of an indispensable substance of plant food, corresponding to the law of the minimum, while in the cold water a greater quantity of nitrogenous compounds is available to the marine producers, owing to the retardation or suppression of this decomposition.*

It is not our purpose to consider here various other bacteriological details, such as the vitality of pathogenic germs in river waters.

A series of other fungi adapted to aquatic life also play an important part in the purification of streams. Foremost among these may be mentioned the filamentary bacteria, of which Sphaerotilus Natans is the most widely distributed species. This fungus is found in all places where extensive processes of putrefaction take place in water, and especially at the points where liquid wastes containing much nitrogenous organic matter are discharged. Such liquids are chiefly the sewage of cities and the wastes from sugar, starch, glue and cellulose factories, breweries, distilleries, etc. The stronger the pollution, the greater will be the development of sphaerotilus, which will be rendered visible by thick whitish flocculent growths on submerged leaves. Under certain conditions Leptomitus Lacteus will also appear, although this aquatic fungus is much more highly organized. Under different conditions other varieties will develop, but none of these deserve as much consideration as the Sulphur Fungi, which constitute another large group.

BEGGIATOA.—Among these the Beggiatoa are of most significance for a river, as my observations have shown that the other sulphur bacteria, and especially the red ones, are found more generally in stagnant water. The beggiatoa, of which a number of species are known in southern waters, can exist only in flowing water; that is to say, where a supply of oxygen is available. Individual filaments of this fungus can always be found in examining microscopically samples of any river mud or sludge, but its rapid growth takes place only when sulphuretted hydrogen is present as a product of the putrefaction of albuminous substances derived from either vegetable or animal matter. The beggiatoa separate the sulphur from sulphuretted hydrogen and store it in their cells. Sulphur is an important source of energy for these plants, and serves the same purpose as carbon for the other organisms in the process of breathing or transpiration. It is, however, not assimilated, but becomes oxidized into sulphuric acid by the oxygen present in the water, and this acid then combines with the lime that is in solution in the water to form gypsum. These sulphur fungi thus have the highly important function of removing from the water the sulphuretted hydrogen that is so dangerous to animal life, and is so offensive aesthetically.

POLLUTION INDEXES.—When found in large quantity in a stream, the various fungi mentioned above afford reliable evidence that the water has been polluted in higher degree than is usual under natural conditions, and they accordingly serve as guides to the source of the contamination. All of them have a great purifying power, but where large quantities of marsh gases rise from putrefying mud, they become entirely powerless, as the bacteria of putrefaction are then exclusively at work. The discovery of guiding forms of fungi has become of great impor-

*Remark by Prof. R. Kolkwitz on the action of oxygen: The question of the presence of atomistic oxygen in plant cells requires more thorough investigation, as it has not been found outside of the plasm. Compare W. Pfeffer, "Contributions to the Knowledge of the Processes of Oxidation in Living Cells," in Abhandl. der Math.—phys. Klasse d. Kgl. Sachs. Ges. d. Wiss., 1889, Vol. 15, p. 438. Marsson maintained that living specimens of Riccia Fluitans were capable of forming active oxygen.

*Remark by Prof. R. Kolkwitz. According to Nathanson, the transposition of organic food matter by oceanic currents, such as those from the bottom to the surface, is an important feature for the growth of the plankton. See Internat. Revue der Ges. Hydrobiologie u. Hydrographie, 1908, Vol. 1.

tance in arriving at a correct judgment of the quality of a water, as they furnish us with much more characteristic and quicker results than the chemical analysis of samples of water taken arbitrarily.

We must also bear in mind another physiological process by which plants manifest further similarities in metabolism or change of matter to that of animals. A plant builds up its substance in the same manner as an animal, by forming directly usable food material, especially albumen, from the carbohydrates (sugar and starch) acquired as previously described and from nitrogeneous compounds, for the maintenance of the molecules of living protoplasm; and it is also capable of respiring or breathing like an animal, in the daytime as well as at night, when the activity of assimilation has declined. In this process of breathing or transpiration, which is, however, not localized as in many animals, a plant also gives off carbonic acid and absorbs oxygen, like an animal. The same is likewise true of the bacteria, in addition to their fermentative activity.

If the materials which are produced in the green cells of a plant from inorganic food remained therein unaltered, they would represent an accumulated dead capital. By the breathing process, however, the heat which is made latent in assimilation becomes liberated by the decomposition of a portion of the carbohydrates. When there is a deficiency of oxygen in the water, as happens from the discharge therein of putrescent liquid wastes, the aquatic plants are deprived of the possibility of breathing and must perish; this fate befalls the higher classes of aquatic vegetation as well as the lower ones, like the algae, and especially the phytoplankton.

The breathing or transpiration of plants is also accompanied by certain disadvantages in the case of stagnant bodies of water, in which the oxygen consumed by the animal life is not restored during the night. Thus it was observed that in trout ponds which contained an excess of filamentous green algae, numerous fish died about daybreak, having been suffocated from lack of oxygen. The more intense the growth of such aquatic plants during the daytime, the more energetically will their breathing process proceed; and this may readily exhaust during the night the greater part of the oxygen contained in a confined body of water, especially in the warm season. This breathing is really a combustion of carbon compounds; and as such combustion is facilitated by an increase of temperature, it follows that up to a certain limit the transpiration of the algae will be the more copious in proportion as the temperature of the materials and their surroundings increases. A reasonable explanation is thus at hand for so unusual a phenomenon as the death of healthy fish in pure water.

THE BOUNDARY LINE BETWEEN PLANTS AND ANIMALS.—In the foregoing much consideration has been given to the aquatic food producers, whose significance in maintaining the purity of our streams has not been recognized sufficiently up to the present time; and we have also become convinced that the animal world with its innumerable species is dependent on the synthetic work performed by plants. No animal is capable of making, like the plant, the food required for its maintenance out of inorganic matter; and this fact affords a marked distinction between plants and animals, or between food producers and food consumers. The boundary lines that were formerly drawn between the animal and vegetable kingdoms have been obliterated by recent investigations. There are, however, many organisms of doubtful character, in which the peculiarities of both kingdoms are more or less mixed and blended., and which are therefore claimed by both botanists and zoologists. Such organisms possess the fundamental properties of living protoplasm, namely sensation and motion, which are fully developed in the higher stages of animal life, while in plants they are manifested only in exceptional cases.

The Green Flagellates, which move by means of their flagellae, must be regarded as plants, as they excrete oxygen by means of their chloroplasts. This peculiarity does not belong to any animal.*

Among these flagellates the Euglenas are of great importance in the transformation of putrescent matter. They not only absorb such matter directly, but they also produce oxygen while in the sunlight, and thus oxidize compounds that have been reduced by putrefactive fermentation, as well as offensive gases. The Euglenas and their relatives are therefore found mainly in nauseous pools, whose surface they cover with a green scum. They appear on every sewage farm, and especially on the surface of sewage held in tanks. They also develop in great numbers in sluggish indentations of the banks of polluted streams, from which they are carried along by the current. When found plentifully in the plankton, they afford proof that the water has been contaminated.

MODES OF SUSPENSION.—It is evident that the micro-fauna which are provided with well-organized means of motion can remain suspended in the water more easily than the micro-flora. If the term "plankton" is understood to embrace all living organisms that float or move involuntarily in a body of water, it becomes necessary to determine by microscopical examination how the ability of the organisms to remain in suspension is attained. Primarily, this will be increased by a considerable enlargement of the surface of the cells in proportion to the volume. In the case of the algae, and especially the silicious algae, the individual cells are provided with hairs or spicules which are sometimes arranged so as to act like a parachute; in other species the cells form colonies shaped like a ribbon, a chain, a star, etc., whence they are designated as belonging to the ribbon, chain, or star type, while others are spindle or drum-shaped. Such extensions of body are also very common in animals, especially in certain crustaceans. Lastly, but not in least degree, the products of assimilation are of importance in regard to suspension, such as the formation of fat in diatoms and the excreted gases in colonies of algae. By these various structural and functional means for remaining in suspension, a nearly uniform distribution of the constituents of the plankton is accomplished. This varies with the time of day in the different strata of the water, and thus insures a thorough utilization of the organic matter by the plants. In water strongly contaminated by dissolved organic matter, it is difficult to find a single drop that does not contain some living organisms which are constantly engaged in the work of purification.

PLANKTON-PRODUCING CAPACITY OF WATERS.—The capacity of our waters to produce plankton may be indicated by a single example. During the months of February, March and April, a species of diatom called Melosira Laevissima constituted the main portion of the plankton in Great Plöner Lake; and it was estimated by Zacharias that in the middle of March the aggregate weight of these minute plants, reckoned as fresh substance, was 31,000 cwt., as a single draft of the plankton net at a depth of only 8 ft. (2.5 m.) yielded about 16,000,000 Melosira cells. Such organisms vary in kind with the conditions for nutrition and propagation, and these in turn depend on thermal influences. The annual periodicity or seasonal distribution of the plankton is therefore variable. The maximum is reached under the favorable conditions of light and heat in summer, when the plankton has to perform its hardest work and is required to remove matter which putrefies more rapidly at a high temperature.

Under relatively unfavorable conditions of the flowing water of the river Elbe near Hamburg, R. Volk found 33,650 algae per c. c., counting the colonies and cenobes only as units. Still greater is the number of algae in water of a greenish color, like that of Lietzen Lake, in which R. Kolkwitz counted about 400,000 algae cells per c. c. It is thus seen that Nature always acts in a helpful manner; but her powers in the purification of water have not yet been sufficiently appreciated, and often her help is not only rejected, but is also directly nullified by the addition of too large a quantity of chemicals to the contaminating liquid wastes.

Animal Plankton: Food Consumers.

BACTERIA EATERS.—Let us next take up the consideration of the most important groups of Animals which help to purify polluted water. Among the protoza, which in comparison with the metazoa have the morphological value of a single cell, the colorless Flagellated Infusoria may be cited first as food consumers. By means of their small lashes, they direct minute particles of food, bacteria, etc., into their mouth-vacuoles which retain them. The numerous species of monads are thus typical bacteria-eaters, and in stagnant, putrefying water they often develop in extraordinary numbers. There are also many kinds of Ciliated Infusoria that eat bacteria. They are somewhat more highly organized than the preceding class, and usually have a mouth-aperture with a passage-way to the interior. With their cilia or their undulating membranes they produce whirling currents in the surrounding water containing bacteria and other minute particles of food, including the flagellates just mentioned, whereby such bodies are brought into their vacuoles. These relatively large unicellular organisms thus dominate over the other living organisms in their vicinity, according to their size, like a cannibal among fish. Many of the Metazoa, including the Rotatoria, are likewise bacteria-eaters, and obtain their food in the same manner as the ciliates. Besides bacteria, this food material embraces other bacteria-eaters, diatoms, small algae, etc. If many bacteria-eaters are found in a water, it can safely be inferred that many bacteria are present, and hence also a quantity of putrefying substances, thus rendering a tedious counting of germs wholly unnecessary before expressing an opinion as to the sanitary quality of the water.

A great horde of lower animals is therefore striving incessantly to destroy the bacteria. If the latter disappear, the bacteria-eaters will also vanish, as they cannot find adequate subsistence in the purer water, and must either starve or become the prey of other animals. Heretofore it was believed that the bacteria died gradually and were subject to a process of sedimentation; but if such were the fact, the beds of our streams would present a very different appearance. It is also highly improbable that an actual settlement of such extremely small organisms can take place in a stream having even a moderate current. Obviously some of the bacteria will be dragged to the bottom along with the heavy matter in suspension, but the great majority will not settle. Experiments in this direction have been made for improving the condition of the water in large aquaria and fish ponds by the precipitation of clay; but few have thought of the natural biological processes of water purification, because an unexpectedly extensive view of these processes has been gained only quite recently by planktological and thorough hydrobiological investigations.

OTHER FOOD CONSUMERS.—Among the organisms that are carried in suspension in water, the minute Crustacea must also be considered. They are found in all seasons in the plankton of rivers, although in less quantity in swiftly-flowing streams. At one time the Cladocera, or water fleas, will predominate, while at another time the Copepoda will be the more numerous, according to their cycle of propagation. Their significance for the purification of water has likewise not been sufficiently appreciated. Concerning the quality of their food, numerous but not conclusive observations have been made. Some investigators assert that they live only on animal food, such as protozoa, while others claim that they use only vegetable food, such as diatoms and other minute algae; but it must be remembered that both protoza and minute algae usually adhere to decaying detritus of animal and vegetable origin.

An enormous multiplication of Daphnia has been observed in highly-polluted village ponds in which, however, various oxygen-producing algae, and especially the euglena previously mentioned, rendered respiration or breathing possible. The question is, what becomes of the great quantities of offal and excreta, the many remnants of decaying plants, the refuse of communities, and the finely-divided factory wastes of every description, which find their way into our streams, even under normal conditions, if a large portion thereof is not consumed by the aquatic detritus-eaters and the omnivorous fauna before settling to the bottom. By increasing the discharge of sewage into a river, a very large increase in the number of water-fleas has resulted, as was observed at Hamburg and elsewhere; and because the substantial value of the crustacea is materially greater than that of the rotatoria, the production of living animal substance is greater at all times in the sewage-polluted portion of the river than in the clean-water portion. Most of the larger crustacea are omnivorous, and many of them do not spare even their own progeny.

FOOD FOR FISH.—In addition to the bacteria-eating and omnivorous animals cited, there are many other species, especially rotatoria and large ciliata, which feed preferably on algae, as their digestive cavities are frequently found stuffed with green algae and brown diatoms. All of these minute animals, and particularly the small crustacea, are of importance as food for fishes.

*Remark by Prof. R. Kolkwitz: From other points of view, the main difference between animal and vegetable organisms is found in the fact that non-parasitic animals have a mouth-cavity into which they can take solid food, whereas true plants are nourished exclusively by dissolved matter. Further studies in regard to the occurrence of such mouth-cavities (vacuoles) in the contested groups of organisms, and in regard to their mode of nutrition, are very desirable.

and chiefly for young fish. After consuming the contents of their egg sacks, the latter take for their first food the very small animalcules, such as rotatoria and young crustacea; as their size increases, they feed on full-grown crustacea, and so on until they finally become the prey of larger fishes. The plankton thus forms the beginning of the cyclical course of matter for a fish. Carp can feed exclusively on plankton crustacea until they attain a weight of one pound. The putrescent matter that finds its way into our waters is thus transformed into useful fish-flesh; and from the relations of the interchange of matter between plant and animal, it becomes evident that **a certain degree of pollution of a stream is necessary from the point of view of social economy.** [Black letters ours.—Ed.]

In the plankton of ponds, the animal components usually preponderate over the plants; hence we find that the slower the current of a stream, the more closely does its plankton agree in composition with that of a pond, and the algae that cause "water blooming" are then also found more plentifully. In rapidly flowing streams, on the other hand, all forms of organisms are less abundant, and the maintenance of the purity of the water depends more on the attendant physical factors than on the plankton. This is confirmed by all the examinations of streams that I have made in various parts of Germany; and especially was such the case in the Rhine, which contains little plankton, and some of its tributaries, also in the Danube and other similar large rivers, in contradistinction to the more sluggish rivers Spree and Dahme, the latter of which is very rich in plankton and decomposable organic matter throughout the entire year.

It may also be said that the greater the quantity of impurities reaching a stream, the stronger will be the development of the plankton, and the greater the amount of work it will have to perform by means of its nutrition and growth. Nature always endeavors to help herself. The supply of fresh matter and organisms is obviously essential to the renewal of the plankton of a stream, and both of these are derived from coves, abandoned channels, and tributary ponds and lakes, many of which occur in the drainage areas of the rivers Spree and Dahme, for example. In the plankton of the waters of the Zoological Garden of Berlin, which are diverted from and returned into the Spree, I found in a single year more than 200 species of organisms, which led me to describe these park waters as culture tanks for numerous kinds of algae that are capable of keeping the water clean throughout the entire year.

Animal Life on Stream Bottoms.

In the foregoing we have considered certain groups of organisms that live in suspension in open waters, and we should next glance upon the Bed of the Stream, which is not less interesting. In collecting and concentrating the plankton, a net made of very fine silk gauze is employed, but for examinations of the bottom, the solid materials must be brought to the surface by means of a suitable dredge. Such materials consist of sand, mud or sludge, according to the character of the stream at the time. If the dredgings consist mainly of fine and somewhat rounded grains of sand, they will usually contain a number of mollusks or shell-fish, which feed on the living plankton and also on the dead detritus. In most rivers, both large and small mollusks are found, ranging from Unio Pictorum and other large Anodonts down to very small varieties. At shallow places the Dreissensia, or migratory mollusks, will often be noticed adhering with their byssus or silky fibers to stones and other objects. My observations on the river Spree and all of its tributaries indicate that in their free-swimming young or larval states these mollusks constitute the main part of the plankton during the springtime, and that their food then consists of the smallest particles of organic matter suspended in the water.

In places where the bottom is rather muddy, as in the Spree above and below Berlin, great quantities of Aquatic Snails, particularly Paludina and Bythinia, are often obtained by dredging. These snails breathe with gills like the mollusks, while other varieties that dwell in mud, such as Limnaea and Planorbaea, breathe with lungs and appear often at the surface of the water. The aquatic snails play an important part in the oecology of water by consuming decaying vegetable matter, and thus removing many products of putrefaction. They also have much significance as food for fishes, especially roach and tench. The Paludina are found mostly in mud, while the Limnaea and Planorbaea prefer to stay on sunken leaves, branches, roots and trunks near the shore.

Representatives of other groups of animals, such as fresh-water sponges or Spongillae and moss-animals or Bryozoa also grow on submerged wood, reeds, stones, etc. In the case of the sponges, a current of water is constantly sucked through the alimentary passages, which retain the food material, and is then expelled from the cloacal passage. It is a fact that spongillae develop most profusely where the stream is most contaminated by municipal sewage, or "by refuse of the most incredible description," according to a certain author, and that they grow in much smaller numbers in ponds of clear water. Most species of bryozoa also seem to live on organic wastes or the products of the decomposition of vegetable and animal matter. A great variety of such bryozoa was found in the dark inlet chambers of the water-works of Hamburg and Rotterdam at a time when the river water contained large quantities of organic matter derived from a profuse development of the alga called Crenothrix Polyspora. These bryozoa, along with Spongilla Fluviatilis, are often found in water mains and are sometimes called "pipe moss." I have found a thick coating of bryozoa growing on planks in the river Panke, which is strongly polluted and always carries many fungi in its current.

The sponges and moss-animals multiply by sexual propagation and develop from flagellated larvae. Last July [1909] the sponge larvae appeared in large numbers upon the surface of the old filters of the Berlin water-works at Tegel Lake. My numerous examinations of the plankton and bottom of European rivers show that the sponges are very widely distributed, and in every examination that I have made of samples taken from our North-German streams, some spicules were found. These little bars constitute the framework or skeleton on which the organic substance of the sponge grows.

The relation of the mollusks, spongillae and bryozoa to the plankton is a manifold one, since all of these organisms in their early states of development are found therein, and more especially because in their more fully developed states they eat both the plankton and the pseudo-plankton, as well as small masses of fungi together with the adherent protozoa and nematoda, and thus contribute to the purification of the water in much higher degree than has hitherto been estimated. The horde of snails, however, that creeps over the mud and cleanses the submerged wood and stones, thrives mainly on the algae and fungi which are first induced to grow by decaying matter, and prevents the ultimate putrefaction of these organisms by eating them.

An instance of this kind is afforded by my observations in 1902 of the streams that received the drainage waters from the various sewage farms of Berlin, and especially during the winter. It was found that after traveling a distance of only one kilometer (0.6-mile) along the course of the streams, very few traces of the large masses of fungi which were continually discharged from the main underdrains could be detected by means of the plankton net and the dredge, but it was noticed that countless representatives of the molluscan fauna were always present at this distance. These mollusks destroyed the masses of fungi that settled to the bottom, and were zealously assisted in this work by a number of species of the larger crustacea, particularly Asellus Aquaticus. A single haul of the dredge would often bring up hundreds of these creatures, young and old. If the polluted stream or brook has a rapid current, the water will be thoroughly oxygenated and thereby often lead to the profuse development of small shrimps, Gammarus Fluviatilis, which likewise feed preferably on aquatic fungi and the adherent protozoa.

We thus see that, simply in the pursuit of their food, all of these minute creatures can easily perform a task which the skill of mankind has hitherto been unable to accomplish. Many experiments with aquaria have demonstrated this fact, but the proof has been greatly strengthened by my numerous studies of long stretches of rivers. Former views about the nature of river mud were rather vague and obscure, and aside from some bacteriological studies, few comprehensive investigations thereof have yet been made. It is certain, however, that without Nature's assistance, also, at the bottom of our rivers, the remaining factors of the self-purification of our waters would soon fail.

If a sample of mud brought up from the bed of a stream is placed in a glass, innumerable small grooves or channels can be seen after a few hours on its surface at the sides of the glass. On closer examination it will be seen that these grooves were formed by thin worms which live in and upon the mud. They are mostly Oligochaetae and principally Tubificidae. In addition to these worms the mud, when examined under the microscope, will also be found to contain a number of very minute and colorless filamentary worms, or Nematoda, which find conditions for existence even in strongly malodorous mud. They also appear occasionally in the plankton, and indicate that highly polluted mud on the bottom has been stirred up by eddies in the current.

Malodorous mud also contains many larvae of Insects, provided that the superincumbent water is not entirely destitute of oxygen. The dark-red larvae of certain midges, especially Chironomus Plumosus, are very common in such mud, and those of the species Tanypus are also frequently found. The larvae of our Gnats, however, are found mostly in small bodies of stagnant water. In mud containing much decaying vegetable matter the larvae of numerous other insects will be found, such as the Ephemera, Cloediptera, Phryganea, etc., as well as the larvae of Water-Beetles, which prey on the former kinds. All of these subsist on the microphytes and microzoa that settle to the bottom. They grow quickly and, before reaching their final development, they become the principal food supply for those species of fishes which seek their food on the bottom, especially Tench and full grown Carp. Other varieties of fish also capture these red larvae, as I have often found the digestive organs of Sticklebacks and other species filled with them.

The innumerable worms and insect larvae, and especially also the fishes that hunt for them, contribute vastly to the continual loosening of the mud and the transportation of its finer particles by the current, whereby these particles are subjected to further oxidation by exposure to better aerated masses of water, and are also rendered accessible for the extraction of food by all of the detritus-eaters mentioned. More or less extensive banks of mud are always formed below eddies and obstructions, but a limit to the exclusively putrefactive fermentation thereof is set by the larger fauna. These creatures are ably assisted in this work by countless representatives of the microfauna and microflora, the former consisting mostly of the typical protozoa and rotatoria of sewage, and the latter of ground diatoms along with certain fungi and algae, chiefly Oscillatoria.

If the bottom of the stream has not been completely sterilized by injurious chemicals, its condition will not remain stationary or fixed in composition, owing to the persistent activity of its small inhabitants. The bed of the stream is therefore not merely a storage place for many kinds of sediment, but is rather a place adapted to the decomposition of all the organic matter in the sediment.

There are also bodies of water like the Black Sea in which a descending circulation is lacking, so that there is not enough dissolved oxygen at their bottoms to oxidize the organic substances; the result of this condition is that the sulphates become reduced by dissociation of oxygen to sulphides, whereby the deep strata of water are impregnated with sulphuretted hydrogen.

In shallow streams the sedimentary matter is distributed more rapidly over extensive areas of the bottom than in deep bodies of water; and in shallow ponds and lakes the wind is an efficient agent in the distribution of such matter. Certain representatives of the larger fauna, such as mollusks belonging mostly to the Dreissensia family, settle near the shores where the water is usually kept in motion and well aerated; while in sheltered coves and bays, there is always a growth of aquatic plants, such as Reeds, Rushes and Sedges, between the stems of which many small aquatic animals pass their lives. In other places a submerged forest of more highly-organized water plants, such as Myriophyllum, Ceratophyllum, Anacharis, etc., will be found, which teems with minute animal life and extracts, like the algae, much organic matter and carbonic acid from the water.

In quiet coves we may also find under certain conditions a growth of filamentous algae, especially those of the Zygnemaceae family, which often develop in enormous quantity. They are lifted to the surface of the water by the gases evolved in the process of assimilation, and are then dispersed by the wind or current; but by means of their dual mode of nutrition they are able to retain their vitality and continue their work of purification for a considerable period of time after such transportation. After death their tangled masses of filament become the habitat of innumerable minute animals, particularly worms,

which multiply rapidly and furnish in turn a good supply of food to young fishes.

We thus find in our waters the most diversified relations of interchange of matter between plants and animals, or between food producers and food consumers. Among the latter there is a constant struggle for existence, the final victors being the predatory fishes which are chiefly used for human consumption, and whose food has been evolved in a complex manner from the dead organic matter originally present in the water. On their own death, their bodies become a source of nutrition for the other animals whose progenitors served to feed them. All these biological processes can be recognized and studied much more advantageously in fresh water than in the boundless ocean.

Practical Applications.

BALANCING WASTES AND ASSIMILATORS AND CONSUMERS.—Although the foregoing considerations have shown that our rivers and their inhabitants can readily master the **natural** pollutions, such as the domestic sewage of our cities and certain trade wastes, and that in many cases clean water is again found flowing in streams only a comparatively short distance below the point of contamination, nevertheless it is necessary to bear in mind that the quantity of putrescible and putrefying matter must always be in propor proportion to the volume of water. My observations have established the fact that the sewage of small cities and the drainage waters of sewage farms of moderate size are easily digested by relatively small streams; while, on the other hand, the insufficiently-purified liquid wastes of large isolated factories, which are usually produced in excessive quantity at a certain time in the year, as after harvest, have often caused serious damage through distances of many kilometers in relatively large streams. In such cases a severe loss results to the fisheries.

TRADE-WASTE DANGERS.—Concerning the capacity of a stream to digest or purify sewage and other wastes, definite figures and limits, such as those given by Pettenkofer, cannot be made readily. The maximum quantity of such liquid that a stream can digest, depends not only on its physical characteristics, but also on its individuality in other respects. Both the biological and the chemical factors must here be taken into consideration. If the industrial wastes contain much acid, alkali or other matter that is poisonous to the animal and plant life of a stream, entirely different conditions are presented from those which occur with domestic sewage and harmless wastes. Thus it has been found that tar products have destroyed all the animal and plant life in the mud bottom of long stretches of river, and that alkalies and acids have killed off every kind of fish by attacking the gills and thereby causing death by suffocation. With a proper quantity of harmless organic wastes, on the other hand, the microscopic organisms suspended in the water, as well as the larger flora and fauna, will labor incessantly to keep the stream in a healthy condition.

In regard to injury to fishes, the opinion has hitherto been that the numerous kinds of industrial wastes consisting of finely divided insoluble matter, such as is produced by cellulose, paper, cloth, cotton and rag mills, and also by mines and iron works, are all injurious by their tendency to lodge in the gills. Such waste matter may be either flocculent, or in the form of fine hairs or fibers, or sharp-edged hard grains. My own observations indicate in general that such is not quite the case. A healthy fish has the power to eject all such foreign bodies from its gills. If, however, the gills are irritated by only small quantities of acid, alkali, or even salts, these organs endeavor to protect themselves against the action of such chemicals by exuding a considerable quantity of mucus upon their surface; and the damage is then done by the adhesion of the particles of cellulose, textile fiber, or other matter to this mucus and the accumulation of such matter thereon, until the gills become so completely covered as to cause suffocation. A copious secretion of mucus by the gills is induced by very small amounts of such chemicals in the water. When the chemicals are present in large quantity or strongly concentrated, the gills are destroyed directly by disintegration.

If acids are discharged into a stream, a new factor for the self-purification of the water is introduced by the neutralizing capacity of the dissolved bases. Thus the bicarbonate of lime usually carried in solution in the water will neutralize a certain quantity of the acids; and in the case of sulphuric acid a combination with lime will occur, whereby the resulting insoluble sulphate of lime, or gypsum, will settle on the bottom. Such a self-purifying process, however, is not a natural one, as the acid of the sulphate in the mud is sometimes reduced by other processes to sulphuretted hydrogen. This latter is a well-known poison for fish, but it may be rendered harmless by the operations of the sulphur bacteria, such as the Beggiatoa previously mentioned.

Similarly, if caustic lime is thrown into the stream, it will ultimately be rendered harmless to fish by combining with the free carbonic acid in the water and forming either insoluble carbonate or soluble bicarbonate of lime, the latter being a normal component of many natural waters. This process, however, is not very rapid, and before its completion the water must generally flow through long distances.

Other Factors and General Conclusion.

A consideration of all the remaining factors that enter into the self-purification of a stream would require much more time than is now available, and hence only the more important ones can here be indicated. They are mainly of a physical character, such as the current and the aeration of the water induced thereby; the intensity of the sunlight, and even also that of the moonlight; the more or less rapid sedimentation of the suspended mineral matter in the water; the dilution caused by rain, the inflow of groundwater, and by the various tributaries; the quality of such additions; the influences of temperature, climate and seasons, etc.

The self-purification of a stream thus involves a large number of factors, all of which stand in mutual relationship and interaction like the wheels of a clock, and the main object of the foregoing considerations was to point out the great importance of the action of animal and plant life alone in conserving the purity of our waters.

List of the Scientific Works of Dr. Maximilian Marsson.

1. A series of short articles of a popular scientific nature on the relation of algae and other aquatic plants to fish-life; published about 1896 in various German periodicals.
2. Planktological Studies, chiefly of the waters in the vicinity of Leipzig. Zeitsch. f. angewandte Microscopie, 1898, Vol. 4, pp. 169-256.
3. Examination of the Flora and Fauna in the waters of the Zoological Garden of Berlin. Mitteilungen d. Fischerei-Vereins der Provinz Brandenburg, 1900, Heft 2, p. 197-204.
4. Plankton Relations of several streams in the vicinity of Berlin. Forschungsberichte der Biologischen Station zu Plön, 1901, Vol. 8, pp. 86-119.
5. Microscopical Determinations of Inferior Animals and Plants. Appendix to Passarge's report on the Deposits of Calcareous Mud in the Lakes at Lychen, in Uckermark. Jahrbuch d. Königl. Preuss. Geolog. Landesanstalt u. Bergakademie, 1901, Vol. 22, pp. 147-152.
6. Unsere Spree (Our River Spree). Mitt. d. Fischerei Vereins der Provinz Brandenburg, 1901, Heft 2, pp. 255-267.
7. Report on the Teltow Canal. Ibid, 1902, Heft 1, p. 83.
8. Injury to Fish in the River Peene by the Sugar Factory in Anklam. Zeitschrift für Fischerei, 1901, Vol. 9, pp. 25-80. (In coöperation with Schiemenz.)
9. Hydrobiological and Hydrochemical Investigations in the Rivers Baeke, Nuthe, Panke and Schwaerze. Schmidtmann's Vierteljahrschr. f. Gerichtl. Medezin u. Oeffentl. Sanitätswesen, 1901, 3d Series, Vol. 21, suppl. pp. 1-158. (In coöperation with Lindau, Schiemenz, Eisner, Proskauer and Thiesing.)
10. Principles for the Biological Estimation of Waters by means of its Flora and Fauna. Mitt. d. Königl. Prüfungsanstalt f. Wasserversorgung u. Abwässerbeseitigung, Berlin, 1902, Heft 1, pp. 33-72. (In coöperation with Kolkwitz.)
11. The Royal Prussian Experiment Station for Water Supply and Sewage Disposal. Mitt. d. Fischerei Ver. d. Provinz Brandenburg, 1902, Heft 1, pp. 128-145.
12. Investigations relating to the Pollution of the River Netze by the Wastes of the Sugar Factories in Kruschwitz, Montwy, Amsee and Pakosch during the years 1902-4. (In coöperation with Kolkwitz, Schiemenz and Zahn.)
13. Investigations of River Mud. Mitt. d. Königl. Prüfungsanstalt, Berlin, 1903, Heft 2, pp. 27-33.
14. The Fauna and Flora of Polluted Water, and their Relations to the Biological Analysis of Water. Forschungsberichte d. Biolog. Station zu Plön, 1903, Vol. 10, pp. 60-73.
15. The Flora and Fauna in the Effluents of Several Sewage Clarification Works near Berlin, and their significance for the Purification of Municipal Sewage. Mitt. d. Königl. Prüfungsanstalt, Berlin, 1904, Heft 4, pp. 125-166.
16. Report on the Pollution of the River Main, made to the Ministers of Education and Commerce, Berlin, 1904; printed only as a manuscript.
17. Report on the advisability of p[illegible]itting Water Closet Sewage from the Cit[illegible] f. Hanau to be discharged into the River [illegible]. Mitt. d. Königl. Prüfungsanstalt, Berlin, [illegible]905, Heft 5, pp. 60-129. (In coöperation wi[illegible] Spitta and Thumm.)
18. Report on the Pollution of th[illegible]River Spree, Made to the Minister of Educa[illegible]n, etc., Berlin, 1905; printed only as a ma[illegible]script.
19. Seven Reports on the results of [illegible]he biological examination of the Rhine betw[illegible]n Mainz and Koblenz. Arbeiten aus d. Ka[illegible]erl. Gesundheitsamte, 1907-1910, Vols. 25, [illegible]30, 32 and 33.
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21. Oecology of Animal Saprobes. [illegible]nternat. Revue d. Gesamten Hydrobiolo[illegible]u. Hydrographie, 1909, Vol. 2, p. 126-152 (In coöperation with Kolkwitz.)

The First Chief Engineer of the Union Pacific R. R.

Peter A. Dey, whose death at the age of 86 years was briefly noted in our issue of Aug. 3, lived to see changes, which, when we consider them as having taken place within the active period of this man's life, are little short of marvelous. He began railway surveys in Iowa when that State was the extreme western edge of civilization; when it was largely an undeveloped prairie; when the emigrants to the gold fields of California and the Mormon converts on their way to Utah were crossing the western plains in "prairie schooners." He was the first to engage in actual location surveys for a railway west of the Missouri River. And he lived to see Iowa become one of the richest agricultural States in the Union, with a veritable network of railway lines; to see the western plains and mountains crossed by seven great transcontinental railway systems, with others nearing completion.

Peter Anthony Dey was born on Jan. 27, 1825, at Romulus, Seneca County, N. Y. His father, Anthony Dey, was the eldest son of Dr. Philip Dey, of Preakness, N. J., and grandson of Col. Theunis Dey, an officer of the American Army in the Revolutionary War. The family of Peter A. Dey removed from Romulus to Seneca Falls in 1830, and he attended Seneca Falls Academy until 1840, when he entered Geneva College (now Hobart), at Geneva, N. Y. He graduated in 1844, and for two years studied law in the office of a local attorney.

In 1846 he entered the employ of the New York & Erie R. R. Co. as a civil engineer, and was engaged in surveys along the Delaware and Susquehanna Rivers, later having charge of a division at Grand Bend, Pa. Three years later he was engaged in work for the State of New York on the Cayuga and Seneca Canal, having charge of the construction of the locks at Seneca Falls. Still later he was placed in charge of work on the Erie Canal at Port Byron. In 1850 he went to work with the Michigan Southern R. R., and remained with this road until it was completed to Chicago in 1852, when he was engaged by the Chicago & Rock Island R. R. to survey lines for its western extension.

The following year he went to Iowa and ran a survey across the entire State from Davenport to Council Bluffs, via Iowa City and Des Moines. With the exception of two years spent in Chicago he was connected with the construction of the Iowa branch of the Chicago & Rock Island R. R. as Division Engineer, and as Chief Engineer of the Mississippi & Missouri R. R., under which name that part of the Rock Island system was built. He was Mayor of Iowa City in 1860.

The Mississippi & Missouri R. R. was the forerunner of the Union Pacific. As his principal assistant in his surveys for the former road, Mr. Dey had employed Grenville M. Dodge, who afterwards became distinguished both as a Union General of the Civil War, and as Chief Engineer during the building of the Union Pacific Ry. Under the direction of Mr. Dey, the survey party under Dodge crossed the Missouri River at Council Bluffs in flat boats in the fall of 1853, and the surveys were extended westward into a country then occupied only by the Omaha Indians.

Hostile Indians and barren plains were not the only difficulties encountered by these pioneer engineers. Conditions arose which tried their moral as well as their physical stamina. Such conditions were met by Mr. Dey with an unflinching integrity, even to the extent of unhesitatingly resigning his position as Chief Engineer of the Union Pacific Ry., when the officials of that company turned over the contract for construction to the notorious "Credit Mobilier of America." Before recounting the circumstances of Mr. Dey's resignation, we give an incident which occurred at the time of the early survey just mentioned. The story can be best told in the language of Gen. Dodge*:

> In our surveys to the Missouri River, Messrs. Cook and Sargent, who were the representatives of the Mississippi & Missouri R. R. in Iowa, held large interests in Florence, Neb. (some distance north of Council Bluffs), and were anxious that our line should terminate on the Missouri River in Iowa opposite that point. It was also stated that the river at that point had rock bottom. To settle this point we ran two lines, one down Pigeon Creek (opposite Florence) and one down Mosquito Creek (to Council Bluffs), and as the latter was superior from an engineering point of view, Mr. Dey adopted that line. There was considerable opposition, but his recommendation stood.

Although these surveys were carried as far west as the Platte River Valley, financial difficulties caused a suspension of further progress in the actual construction of the Mississippi & Missouri R. R. long before it reached Council Bluffs. The promoters of the road, however, continued to plan for a Pacific railway and exploratory expeditions were conducted into the western country by both Mr. Dey and Mr. Dodge. At the outbreak of the Civil War the latter entered the army and became a distinguished general. In 1862 Congress passed the bill which made possible the building of a transcontinental railway, and the same year the promoters of the Union Pacific Ry. sent Mr. Dey west to explore a line via Denver, Colo., to the Great Salt Lake in Utah. In 1863, together with Gen. Dodge and others, he was called to Washington to assist President Lincoln in deciding on the location of the eastern terminus of the road, and Omaha, Neb., was decided upon.

In the fall of that year Mr. Dey organized parties to survey a route from the Missouri to the Platte River; and in December ground was broken at Omaha on the first mile of construction work. It was in the construction of these first few miles that the incident occurred which caused Mr. Dey to resign his position, and perhaps had much to do with his final determination to give up engineering. From Omaha Mr. Dey located a line almost due west to Elkhorn, but Mr. Durant, Vice-President, and Col. Seymour, Consulting Engineer of the company, succeeded in having the line changed so as to add 9 miles to a distance of 13 miles.

The claim was made that this would eliminate heavy work and heavy grades, but many saw other reasons for the change, and it was violently opposed by both Omaha and Council Bluffs for fear that the design was to make Bellevue the real terminal. As a matter of fact, nothing was gained from an engineering point of view by the proposed change. The case was carried to the Government, which was to issue bonds at several thousand dollars per mile of road completed, and after a long contest and many reports it was ordered that the change should not be made unless the Omaha and Elkhorn grades were eliminated. Gen. Dodge is authority for the statement that "by the change and addition of nine miles they made no reductions in the original grades, or in tonnage hauled in a train on the new line, over the old line if it had been built."

The company paid no attention to the Government order, or to the recommendations of its engineer, and went ahead on the changed line. The Government commissioners accepted the line thus built and bonds were issued on it. The decision to make the change and the letting of the contracts for a much larger sum than that necessary to actually construct the road to an inside ring of the stockholders of the company (the Credit Mobilier) caused Mr. Dey to tender his resignation in the following letter:

ENGINEER'S OFFICE, UNION PACIFIC R. R.

Omaha, Neb., Dec. 7, 1864.

Dear Sir: I hereby tender you my resignation as Chief Engineer of the Union Pacific R. R., to take effect Dec. 30, 1864, one year from the date of my appointment. I am induced to delay until that time that I may combine the results of surveys of the present year and present them to the company and to myself in a satisfactory manner.

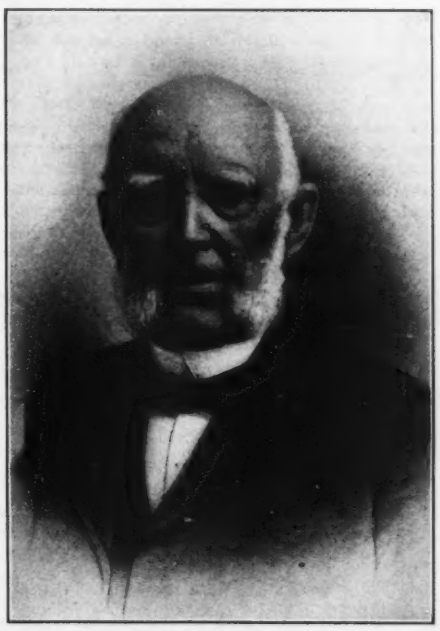
My reasons for this step are simply that I do not approve of the contract made with Mr. Hoxie for building the first hundred miles from Omaha west, and I do not care to have my name so connected with the railroad that I shall appear to endorse this contract. Wishing the road success beyond the expectations of its members, I am respectfully, Yours,

Hon. John A. Dix. Peter A. Dey.

Together with this letter Mr. Dey sent also the following further explanation of his action:

Omaha, Neb., Dec. 7, 1864.

Dear Sir: With this I send you my resignation as Chief Engineer of the Union Pacific R. R.



Peter A. Dey

Co. My reason I have given. I received the contract nearly a month ago. When I first read it, I felt that it was made against my known views, and that I could not be held in any measure responsible for it; but it has since been a constantly recurring subject of thought, and I am not satisfied that I shall be able to acquit myself of all blame if I become an instrument of its execution.

You know the history of the M. & M. road, a road that to-day could be running to this point if its stock and bonds represented only the amount of cash that actually went into it. My views of the Pacific railroad are perhaps peculiar; I look upon its managers as trustees of the bounty of Congress; I cannot willingly see them repeat the history of the M. & M. by taking a step in the incipiency of the project that will, I believe, if followed out, swell the cost of construction so much that, by the time the work reaches the mountains, the representative capital will be accumulated so much that, at the very time the company will have need for all its resources, as well of capital as of credit, its securities will not be negotiable in the market.

From my boyhood I have associated Mr. Cisco and yourself with Mr. Bronson and Mr. Flag—men whose integrity, purity and singleness of purpose have made them marked men in the generation in which they lived. Of course my opinion remains unchanged. You are doubtless uninformed how disproportionate the amount to be paid is to the work contracted for.

I need not expatiate upon the sincerity of my course when you reflect upon the fact that I have resigned the best position in my profession this country has offered to any man.

With respect,

Hon. John A. Dix. Peter A. Dey.

In the improvement work done on the Union Pacific Ry. since 1900, a part was the cut-off west of Omaha, practically a relocation on the original line recommended by Mr. Dey in 1864.

After his resignation from the Union Pacific Ry., Mr. Dey returned to Iowa City and continued in railway engineering work on a north and south railroad until 1869, when he was elected President of the First National Bank of Iowa City, a position which he held until 1878. From 1872 to 1884 he was appointed by the legislature one of the commissioners which superintended the building of the State Capitol at Des Moines, of which it has been said "that a cleaner record of construction of any public work was never made." In 1878 he was appointed Railroad Commissioner, and was reappointed by the two succeeding Governors. When the office was made elective in 1888 he was elected and re-elected until 1895, with the exception of one year, although he was a Democrat and Iowa an iron-bound Republican State. In 1895 he was re-elected President of the First National Bank of Iowa City, and continued in that office until his death.

Mr. Dey was married in 1857 to Miss Catherine Thompson, of Buffalo, N. Y. Of their six children four survive: Marvin Hull Dey, of Iowa City; Mrs. Craig Wright; Curtis Thompson Dey, also of Iowa City, and Mrs. Clarence W. Eastman.

For many years Mr. Dey was a prominent and highly respected citizen of his State and city. He took an active interest in public affairs and was one of the founders and a lifelong friend of the State University, which is located in Iowa City. President George E. McLean, of the University, has said of him: "He knew personally and was helpful to every one of its nine presidents. . . . He was a model of the distinguished and disinterested citizen."

Exports of Iron and Steel Manufactures for the United States increased more than $51,000,000 during the year ending June 30, 1911, as compared with the previous year. The actual figures were $230,725,351 for 1911, as compared with $179,133,186 in 1910. Commenting on these figures, the U. S. Department of Commerce and Labor says:

> This growth of 51 million dollars in the fiscal year 1911, a growth which far exceeds that of any earlier year, was distributed among nearly all the important classes of iron and steel exported. Exports of metal-working machinery, for example, advanced from a little less than 6 million dollars in 1910 to 9⅔ million in 1911; sewing machines from 7½ million to 9 million dollars; machinery as a whole, from 80 million to 104½ million dollars; wire, from 8⅓ to over 10 million dollars; builders' hardware and tools, from 14 million to 17 million; electrical machinery, from 6 million to 8 million; locomotives, from 2½ million to practically 4 million dollars; typewriters, from 8¼ million to 9¾ million; pipes and fittings, from 9½ million to 10⅗ million dollars, and bars or rods of steel, from 4¼ million to 5 million dollars.
>
> Nor can it be assumed that this remarkable increase in total value of iron and steel manufactures exported is due to higher prices, since a large share of the staple products of iron and steel show in 1911 a price level materially lower than that of 10 or 20 years ago. Of wire, for example, the annual average export price has fallen from 3.4 cts. per lb. in 1891 to 2.5 cts. per lb. in 1901 and 2.3 cts. per lb. in 1911; of cut nails, from 2.4 cts. per lb. in 1891 to 2.2 cts. per lb. in 1901 and 1.9 cts. in 1911; and of bar iron, from 4 cts. per lb. in 1891 to 1.7 cts. in 1901 and 1911. The downward tendency which has characterized iron and steel prices during the last decade was still in progress up to June of the present year, the latest month for which figures are available. Pig iron, the basis of the more highly finished articles forming the bulk of the export trade in iron and steel, ranged downward in price from $16.51 per ton in June, 1910, to $15.10 in June of the present year; billets, ingots and blooms of steel, which represent a higher class of material used in producing the finished product, from $27.72 per ton in June, 1910, to $22.13 in June, 1911; steel sheets and plates, from 1.97 cts. per lb. in June, 1910, to 1.76 cts. in June, 1911; structural iron and steel, from $49.76 per ton in June, 1910, to $44.63 in June, 1911; steel rails, from $29.04 in June, 1910, to $28.55 in June, 1911, and wire, from 2.4 cts. per lb. in June of last year to 2.3 cts. in June of the present year.

*"How We Built the Union Pacific Ry.," by Maj. Gen. Grenville M. Dodge. Published as a U. S. Senate Document, ... Reviewed in Eng. News, July 14, 1910. See also article in Eng. News of Oct. 24, 1909, by the same author.

The Crossing of the Western Maryland R. R. Over the Pennsylvania R. R. Near Connellsville, Pa.

On the new Cumberland-Connellsville extension of the Western Maryland Ry.* about 1½ miles south of Connellsville, the line crosses above the lines of both the Pennsylvania R. R. and the Baltimore & Ohio R. R., within a distance of 500 ft. The relative elevations of the roads required that the crossing be made in one continuous bridge some 730 ft. long and the general layout showed that a series of 80-ft. plate-girders would best serve the needs. Both crossings are on a skew. That of the B. & O. R. R. was of a sufficient obtuseness so that ample clearance could be gained under one of the 80-ft. plate-girder spans which were considered about the economic length for this viaduct and which worked out to the desired total length between clearance lines. The Pennsylvania crossing on the contrary was skewed so sharply (22° 25′ from the parallel) that the regular arrangement of plate-girders could not be laid out since the required span would have been some 300 ft. in the clear. The Western Maryland R. R. line here, furthermore, is on a 3° curve adding more complications to the clearance problem. The Pennsylvania R. R. would not permit intertrack piers to support normal length plate-girders, nor was it desired to use a truss bridge such as a 300-ft. crossing would require. After a long study of the situation, the Western Maryland proposed the somewhat novel design described in this article. This design was accepted by the Pennsylvania authorities and is now in process of construction.

Fig. 1 shows the general layout of the Pennsylvania crossing. It will be seen that the clearance lines of the lower road are fully 250 ft. apart on the outer girder lines of the upper road and that even if one span were used across this opening the skew would require a very large and expensive pier at either end. Instead of this long span, two 110-ft. plate-girder spans were used resting on the regularly designed piers at their outside ends and on two heavy interbraced cross-girders at their inside ends. These cross-girders rest on four small pedestal piers located outside the clearance line of the lower tracks, and the intervening space between them is

*Engineering News, Jan. 26, 1911, p. 104.

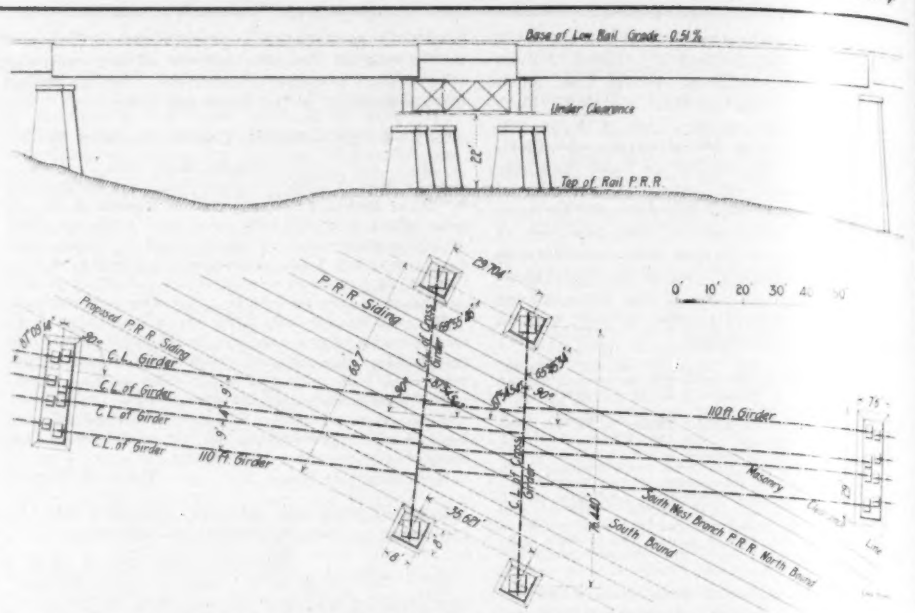


FIG. 1. GENERAL LAYOUT OF OVERHEAD CROSSING OF CUMBERLAND-CONNELLSVILLE EXTENSION, WESTERN MARYLAND R. R. OVER PENNSYLVANIA R. R., NEAR CONNELLSVILLE, PA.

spanned by one short 30-ft. plate-girder span. The cross-girders are shown in detail in Fig. 2. As will be noted, there are two, of similar design, one about 77 ft. and one about 75 ft. long, and each made up of a box-girder 9 ft. 6 ins. deep. Each rests on its two piers on pin-bearing shoes firmly bolted into the concrete piers. On account of the heavy tractive forces acting over the entire structure it was necessary to tie these two girders together very thoroughly, and the very heavy cross-bracing shown in the figure is provided for that purpose.

Riveted to the top plates of each girder are the four pin-bearing shoes which carry the longitudinal girders of the bridge. The 110-ft. girders extending outward from each cross-girder rest directly on the shoes and carry short transverse beams, which in turn carry the small 30-ft. girders spanning the space between the cross-girders. The details of this support are shown on Figs. 2 and 4.

The main longitudinal girders are each 110 ft. long and 9 ft. 6 ins. deep and are cross-braced together in pairs, one pair to each track. The details of their construction are shown on Fig. 3. The short girders, (Fig. 4) each about 28 ft. 9 ins. long, but varying slightly on account of the skew, and 4 ft. deep, are alined differently from the main girders in order to simplify the connection at the ends, and are riveted at one end and bolted at the other to the short cross-beams which in turn are riveted to the ends of the main longitudinal girders, as shown in Fig. 3. The rails are carried on cross-ties, spanning the beams, and banked as shown in the detail

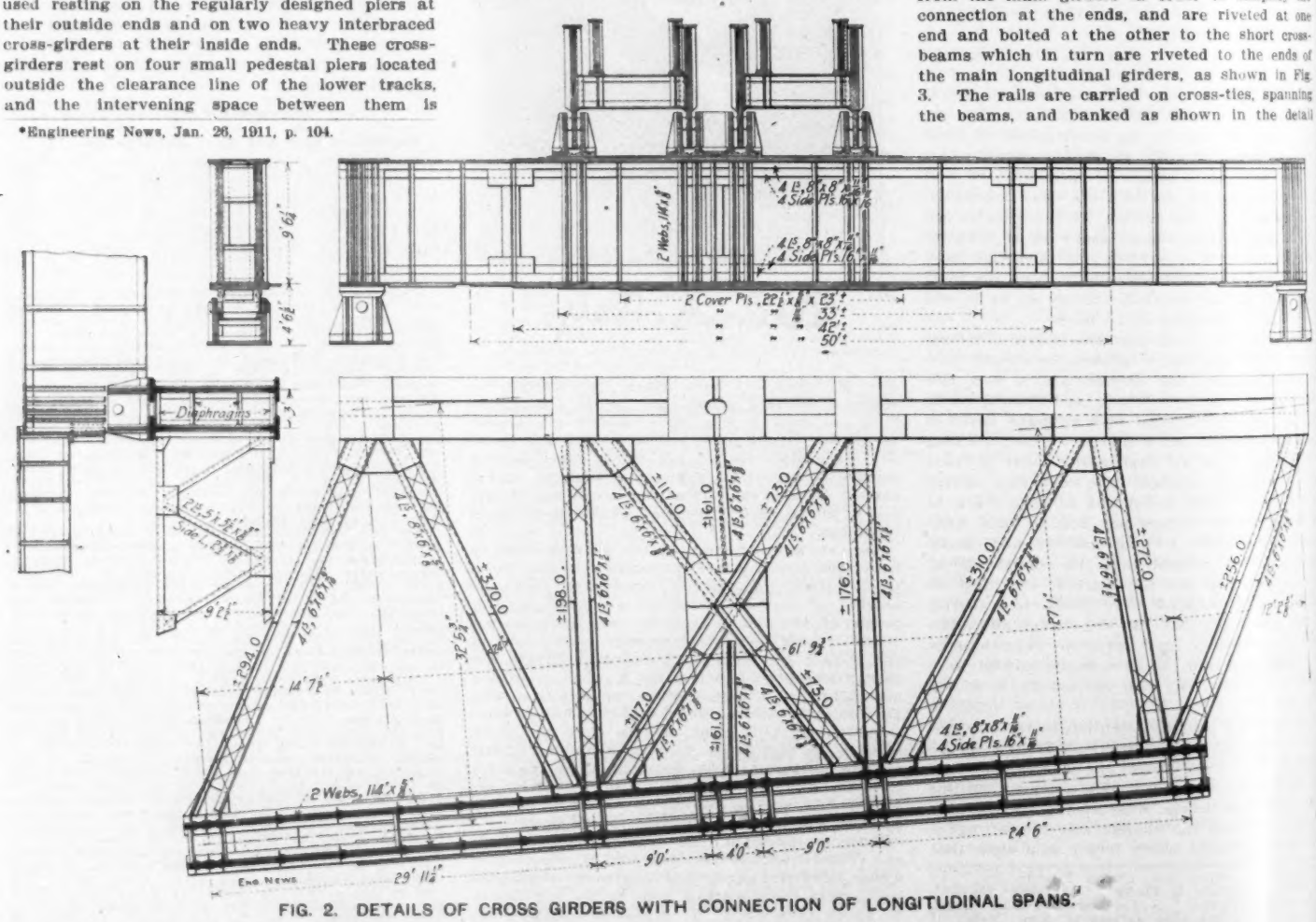


FIG. 2. DETAILS OF CROSS GIRDERS WITH CONNECTION OF LONGITUDINAL SPANS.

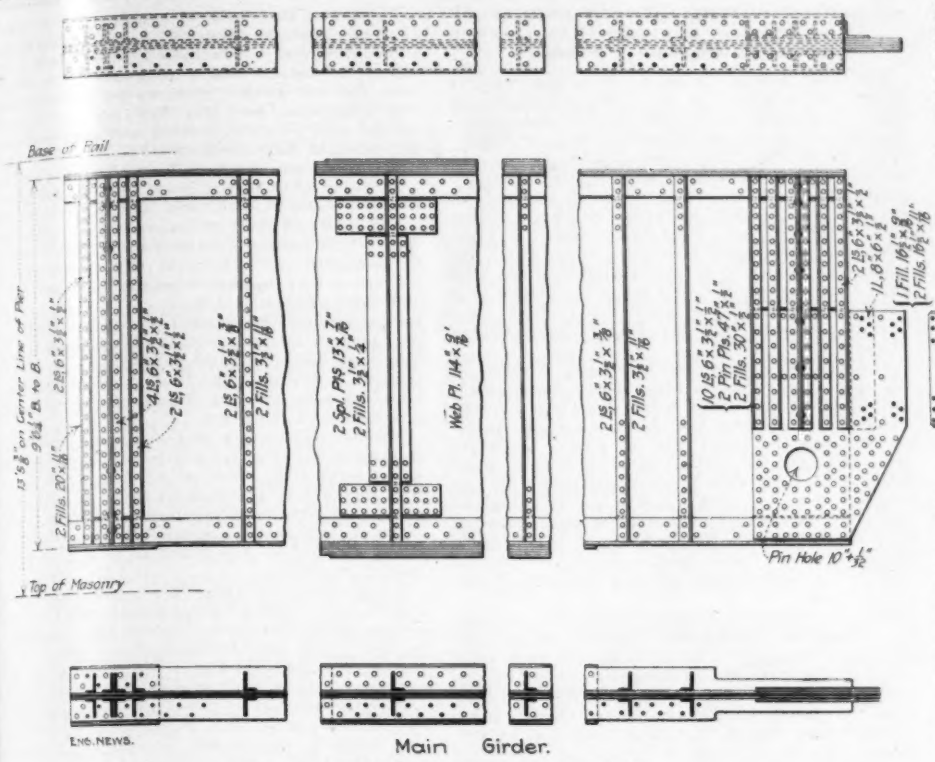


FIG. 3. DETAILS OF THE 110-FT. SPANS.

on Fig. 4, to care for the super-elevation on the curve.

The outside end of each long girder is provided with roller bearings, but between these two bearings the entire built-up structure forming the crossing is fixed, with the various pin-connections noted, allowing free deflection. An exception to this is the 30-ft. girders, which are riveted to one support but are bolted to the other in slotted holes, thus allowing some little movement due to deflection.

The new line of the Western Maryland is using a very heavy loading for its bridges, a 2-8-8-2 Mallet locomotive with 55,000 lbs. on each of the eight drivers and 38,000 lbs. on each of the four tender axles, followed by 5,500 lbs. per lin. ft. of train load. In addition to this load there is a very heavy strain on the cross-girders due to a combination of the tractive forces along the main girders and thus transmitted into the cross-girders and their bracing, and the centrifugal force of the trains going around the curve. This tractive force is figured for two conditions: (1), 250 ft. of loaded double track over the entire crossing and (2), 125 ft. of loaded double track on one side of the suspended span only. The former loading gave the heaviest stresses for the cross-bracing in the end panels and the latter for that in the center panels, each member being designed for the condition giving the maximum stress.

As will be noted from the drawings, there are many complications of both line and grade which make the alinement most irregular and add considerable to the difficulties of detailing.

The whole bridge at this crossing consists of six 80-ft. spans, two 110-ft. spans and the one 30-ft. suspended span, all resting on solid concrete piers. The four pedestal piers are reinforced at each corner by old rails placed in a vertical position near the faces of the concrete to give additional strength against the bending action which the passing trains may possibly impart to the piers.

The design of the skew crossing was originated by Mr. H. R. Pratt, Chief Engineer of the Western Maryland R. R., under whose direction the entire extension is being carried out. The details of the design were worked out by Mr. Albert W. Buel, the consulting bridge engineer of the road, in cooperation with Mr. Paul L. Wolfel, Chief Engineer of the McClintic, Marshall Construction Co., the contractor for the fabrication and erection of the steel superstructure.

Municipal Regulation of the Billboard Nuisance has been upheld in a decision of the Supreme Court of Missouri in a suit brought by the St. Louis Gunning Advertising Co. against the City of St. Louis. The movement for the regulation of billboards in the city named was begun as long ago as 1902 by a Committee of the Civic League of St. Louis. In 1905, the Municipal Assembly passed an ordinance regulating the billboards, which went into the subject in much detail. The company named soon secured an injunction against the enforcement of the ordinance, but on March 1, 1910, Division No. 1 of the Supreme Court upheld the ordinance as valid. One judge having dissented, the company was entitled to a decision from the full court. This decision was handed down on May 9, 1911, a single judge dissenting. The sections of the ordinance in question, according to the "Civic Bulletin" for May 15, 1911 (address: Civic League of St. Louis, 903 Security Bldg.), were as follows:

(1) That no structure, building or shed could be altered, repaired, or removed without a permit from the Commissioner of Public Buildings.

(2) That various fees should be paid for such alteration or repair, $1 being the fee for every 25 ft. of the area of a sign and $1 for every 5 lin. ft. of a billboard.

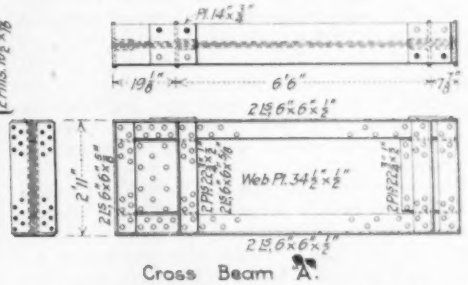
(3) That no rotten or unsafe sign shall be permitted in any place and that no sign exceeding 20 sq. ft. shall be erected on any building without a permit. None but metal signs may be attached to any building if larger than 3½ x 10 ft. No sign shall project more than 18 ins. over the building line, nor nearer than 8 ft. from the ground or pavement, nor to interfere with any fire escape.

(4) No billboard having more than 25 sq. ft. of area shall be erected without a permit from the Commissioner of Public Buildings and on his approval. No billboard shall exceed 14 ft. in height above the ground and there must be an open space of at least 4 ft. between the lower edge of the board and the ground. No billboard shall be nearer than 6 ft. to any building or the side line of any lot nor nearer than 2 ft. to any other billboard, nor shall any such billboard exceed more than 500 sq. ft. in area, nor approach the building or alley line nearer than 15 ft. Rotten or unsafe billboards are subject to removal.

The portion of the court decision upholding the validity of the ordinance is as follows:

In this general statement, we might also add that there is but one virtue connected with this entire business, and that is the advertising itself. This is a legitimate and honorable business, if honorably and legitimately conducted, but every other feature and incident thereto have evil tendencies, and should for that reason be strictly regulated and controlled. The sign-boards and bill-boards upon which this class of advertisements are displayed are constant menaces to the public safety and welfare of the city; they endanger the public health, promote immorality, constitute hiding places and retreats for criminals and all classes of miscreants. They are also inartistic and unsightly.

The amount of good contained in this class of business is so small in comparison to the great and numerous evils incident thereto that it has caused me to wonder why some of the courts of the country have seen fit to go as far as they have in holding statutes and ordinances of this class void, which were only designed for the suppression of the evils incident thereto and not to the suppression of the business itself. The evils incident to this class of advertising are more numerous and base in character than are those incident to numerous other businesses which are considered mala in-se; and which for that reason may not only be regulated and controlled, but which may be entirely suppressed for the public good under the police power of the state. My individual opinion is that this class of advertising as now conducted is not only subject to control and regulation by the police power of the state, but that it might be entirely suppressed by statute, and that, to, without offending against either the State or Federal Constitution.



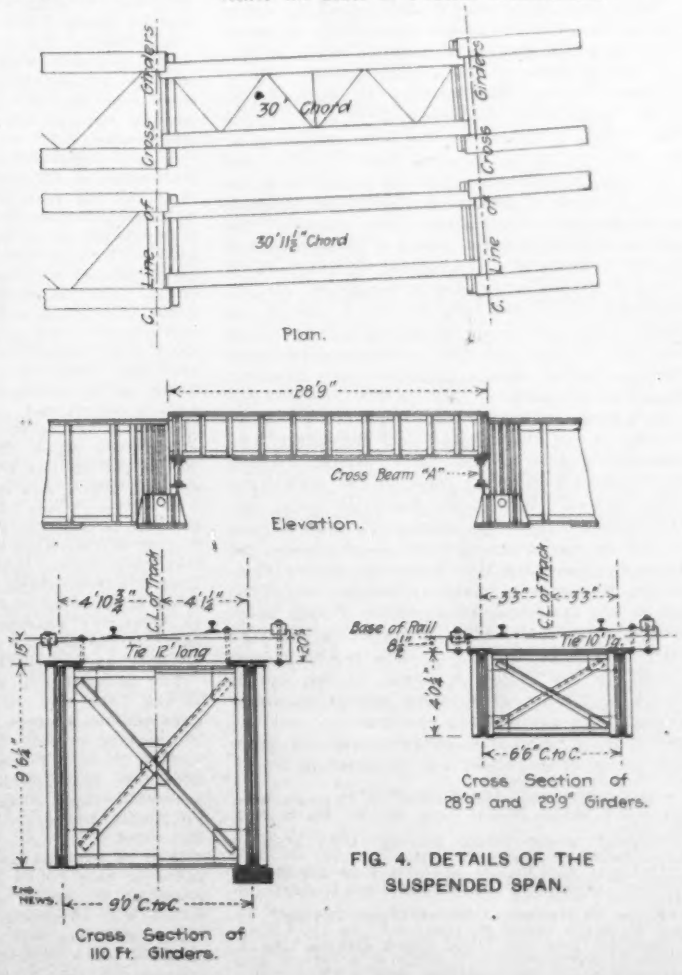


FIG. 4. DETAILS OF THE SUSPENDED SPAN.

Two Reports on Paving Materials and Work in Chicago.

The city of Chicago has been prominent in street paving matters within the past few years owing to two aspects of its work in particular: (1) the extent of the work which has been planned, to replace inferior and defective paving on a large mileage of streets; and (2) the engineering investigations which have been conducted as to the materials and workmanship employed in this extensive work. A considerable amount of information in this direction, both as to description and criticism, has been published in our columns,* and we have received recently two reports on the subject, abstracts of which are given below.

The report of the Chicago Bureau of Public Efficiency is that of a body organized by a number of citizens to carry on the work of supervision of municipal expenditures which was inaugurated by Prof. Charles E. Merriam (an alderman of Chicago) and the Commission for City Expenditures (commonly known as the Merriam Commission). The Commission, however, was an official body composed of members of the council and other municipal representatives; it was not continued by the present administration, and it has now passed out of existence. The general purpose of the Bureau is to make studies of the expenditures of the local governing bodies and to furnish the public with information and suggestions in this direction.

During 1910, an investigation as to the street paving work done under the direction of the Board of Local Improvements was conducted by Mr. A. J. Hammond, M. Am. Soc. C. E., Chief Engineer of the Bureau. This was supplemented by an enquiry as to methods, materials and results in other cities. Conferences were held also with Mr. Samuel Whinery, M. Am. Soc C. E., of New York City, who was one of the experts engaged in the previous enquiry by the Chicago Commission on City Expenditures; he cooperated in part of the investigation and reviewed the conclusions presented in the report of the Bureau.

The report opens with a criticism of the methods employed in the preparation of the specifications now adopted in Chicago, and which are practically those of the Association for Standardizing Paving Specifications; it presents also a discussion as to the monopoly in preservative oils. Both of these matters were discussed by Mr. Whinery in our issue of April 27, 1911, and we need not go further into the matter here, referring those of our readers who are directly interested to the full report of the Bureau. The report suggests that the Board of Local Improvements, under which the paving is done, should carry out work of general investigation, compile statistics, etc.; also that it should publish reports of its work, since in six years it has made but one report, and that contains little more than a list of streets on which improvements had been provided.

The Loop Protective and Improvement Association is an organization of merchants and property owners in the "loop" district (within the elevated loop which encircles the main business center). When the Board of Local Improvements ordered the paving of certain streets in this district with creosoted wood blocks, the Association engaged Mr. Charles K. Mohler, Consulting Engineer, to make an enquiry as to the merits and the proper construction of such pavement, for the information of taxpayers and "the man who pays the bill." His report relates mainly to the subject of wood paving, but it covers a number of subjects related to street paving, such as manhole construction and the provision of municipal conduits for the pipes and cables of public-service corporations.

*"Repaving the Loop District in Chicago with Creosoted Wood Blocks," by W. W. Marr, Dec. 29, 1910.
"Laying Wood Block Paving with Cement Grout Cushion," June 12, 1911.
"Changes in Chicago Specifications for Street Paving," (suggested by Mr. Whinery), April 20, 1911.
"Notes on Creosoted Wood Block Paving," by Paul E. Green, April 20, 1911.
"Specifications for Wood Block Paving," by S. Whinery, April 27, 1911. (This is a review and criticism of the specifications used in Chicago.)

(1) REPORT OF THE CHICAGO BUREAU OF PUBLIC EFFICIENCY.

Creosoted Wood Block Paving.

KIND OF WOOD.—Wood block paving requires careful consideration of the kinds and quality of timber best adapted to traffic and to preservative treatment. These considerations may be understood to include the proper seasoning of the wood. The specifications [of the Association for Standardizing Paving Specifications, adopted by the city of Chicago] designate Southern yellow pine, Norway pine, black gum and tamarack. Southern yellow pine is a trade term which includes the timber of several varieties of the pine family, but chiefly the true long-leaf yellow pine (Pinus palustris), the short-leaf yellow pine (Pinus echinati), and the loblolly pine (Pinus taeda).

The woods of the last two are inferior in strength and subject to rapid decay, and though, when properly creosoted, decay is arrested, blocks made from them lack the strength and durability of the true long-leaf yellow pine. Likewise, what is known as "second growth" timber of all these varieties is very inferior and should be excluded. The very broad experience in Indianapolis with the different varieties of pine indicates that while not all the failures of wood block pavement there have been due to the use of loblolly, practically all of the loblolly blocks have failed.

The provision in the specifications that the annual rings in yellow pine timber shall be not less than four and shall average not less than eight to the inch will exclude very little timber of any quality found on the market under the name of Southern yellow pine. The Chicago specifications require not less than six to the inch.

KIND OF OIL.—Of no less importance is the selection of the preservative and the method to be employed in treating the wood. If the natural tendency to decay can be arrested, the only factor to be considered is the wearing effect of traffic on the wood block. Consequently there is required merely that quantity of any preservative which can be employed most economically to keep the block from decay so long as it will bear up under the traffic.

The quantity and character of the preservative used for paving blocks in the loop district need only be sufficient to preserve the wood from natural decay for from 10 to 12 years at most. For some of the residence streets and alleys, where the pavement will not wear out (ordinarily) for a much longer period, the amount and quality of the oil used should be adequate to prevent natural decay for the longer life of the pavement.

It is desirable that the timber for wood block pavement be air-seasoned preliminary to treatment, for the reason that, in some of the several patented processes of treating green timber, where a heavy tar oil is used, such high temperatures are required in order to secure the desired impregnation of the block that the wood fiber is injured. The "bleeding" of the pavement, hereinafter referred to, is another fault which has been attributed to the process of steaming the blocks used in Chicago. The explanation is that when the high pressure necessary to introduce the heavy oil is applied to the saturated fiber, moisture is imprisoned, and its subsequent vaporization when the block has been laid forces the oil out of the wood. The minimum specific gravity of the oil has been raised from 1.01 to 1.03 or 1.04, while the maximum has been held at 1.08. This range in values covered European practice in general, as well as the specific practice of the railways of this country. Within the last four years, however, it has been claimed that a waterproofing material is most to be desired in treating wood blocks, and that, in order to effectively waterproof the blocks, it is necessary to use heavier oils than the pure coal-tar creosote, and a greater quantity (impregnation).

The specifications which were used in Chicago during 1910 required an oil which "shall be a **pure coal-tar product,** free from adulteration, * * * the specific gravity (of which) shall be at least 1.10 at 25° C." Though no maximum was specified, this high minimum permitted, or rather required, either a large admixture of coal-tar pitch with creosote oil or the use of refined coal-tar alone.

If it be true, as claimed by some of the advocates of this heavy-gravity oil, that when the pores of the wood are filled with a substance which will effectually and permanently exclude moisture, decay will be prevented without the presence of a fungicide such as pure coal-tar creosote oil, then it is only a question of finding a substance that will effectually seal the wood against moisture. With what knowledge of the subject there is now available, however, it seems unwise to assume that a fungicide is not necessary for the proper preservation of the wood. The experience with the new material has extended over so short a time, and such undesirable features have developed, that the good qualities it may possess have been clouded.

In order to render a wood block decay proof it would seem that the only safe course is to use a sufficient quantity of high-quality creosote oil. But if it is desired also to waterproof the blocks by complete cell treatment with heavy-gravity oil, there may be added to the creosote base a sufficient amount of refined coal-tar pitch, or of special residues resulting from the distillation of coal-tars, or a heavy portion of water-gas-tar oil. The tars, however, must be such as will assimilate with the pure coal-tar creosote and have such characteristics as will permit complete impregnation of the block.

Further illustration of the permanent effect of treatment with lighter oils is had in recent tests which have been made of wood block pavement that was laid in Indianapolis some 12 or 14 years ago. Block that had received but a 12-lb. treatment of preservative, which had a specific gravity of about 1.04, was found to be still in satisfactory condition.

EXUDATION OF OIL.—There was considerable complaint in Chicago last summer, and there has been a great deal more this summer, because oil in the blocks has exuded so freely that a thick coating of tarry substance has appeared on the surface. This is tracked into houses and stores, to the destruction of floors and floor coverings, and, though an attempt to relieve the annoyance was made in some places by scraping the pavement, the tarry coating reappeared.

One explanation attributes the cause of this to what may be termed the adulteration of creosote oil or dead oil of coal-tar, which has a specific gravity ranging from 1.03 to 1.08, with coal-tar pitch, in order to raise the specific gravity (as required by the specifications) to 1.10 or higher. It has also been suggested that the trouble is due to pitch filler between the blocks, which, being forced out of the interstices up on the surface by the expansion of the block, unites with some of the lighter oils of the preservative and forms the tarry coating.

In most cases, however, there was no doubt that it was the heavy coal-tar oil used in the treatment of the block which was exuding from the wood. Under the influence of heat and its expansive effect on the blocks, augmented possibly by the evaporation of the moisture imprisoned during the steaming process before referred to, the tar is forced out of the pores of the wood and forms the coating, whereas, if creosote oil alone is used, the slight exudation is not sticky and objectionable as is the tar.

Reference may be made to the experience of the city of Indianapolis, which has laid a large mileage of creosoted block and was among the pioneers in the laying of such pavement. The earlier pavements there were treated with from 10 to 12 lbs. per cu. ft., using pure creosote oil which had a specific gravity of about 1.04, and there was no trouble from exudation. Almost four years ago, however, the specifications were changed and an oil requiring the admixture of coal-tar pitch to bring it up to the higher specific gravity limit was adopted and a heavier treatment was used. From the beginning of its use there was trouble and annoyance caused by the exudation of tar.

Last year a new specification was adopted which called for creosote oil derived from the distillation of pure coal tar, which should be free from any adulteration whatever or any mixture of undistilled tar and should have a specific gravity, at 140° F., of not less than 1.04. The oil used had a specific gravity of 1.075 at 77° F., and no trouble has been experienced since it was adopted.

The specifications of the borough of Richmond, New York City, call for an oil having a specific gravity of at least 1.07, and very satisfactory results have been obtained thereby. It has been the practice in Europe to air-season the timber thoroughly before treatment, and pure creosote oil having a specific gravity ranging from 1.03 to 1.055 has been used and no bleeding of the blocks has been noted.

ECONOMY IN WOOD BLOCK PAVING.—An appreciable economy could be effected by intelligent variation in the depth of blocks. The present practice is to use block of a uniform depth of 4 ins.; but 3½ ins. would be sufficient depth for block on residential streets, and even 3 ins. would suffice on alleys and very light traffic

streets. With a 20-lb. treatment of preservative, the 3½-in. block would cost approximately 20 cts. per sq. yd. less than 4-in., and 3-in. block would cost 10 cts. per sq. yd. less than 4-in. On the basis of $2 per sq. yd. for block alone, from 10 to 20% could be eliminated in the cost of block, and the character of pavement sufficient for the actual traffic conditions still could be obtained. Having in mind the large amount of wood block pavement which the city contemplates laying, serious consideration should be given to the important economy to be secured by using wood block of varying depth to meet the varying traffic demands.

Asphalt Paving.

MATERIALS.—On main thoroughfares the surface mixture is so kneaded and compressed by heavy traffic as to afford a greater resistance to the deleterious effect of moisture and the chemical action of the air than on light traffic streets, where such kneading process is lacking. Consequently, less bitumen and oils are required on main thoroughfares and a harder pavement may be laid. In order to withstand atmospheric conditions successfully, a softer pavement is necessary on light traffic streets. It should contain a larger proportion of oils and bitumen, which give a high penetration. The surface of any particular street having uniform traffic conditions should have uniform penetration. The specifications provide that the penetration of asphaltic cement shall range from 30 to 100°. This "penetration" refers to the depth (in hundredths of centimeters) which a No. 2 needle, weighted with 100 grams and permitted to act for five seconds, will penetrate when the cement is heated to a temperature of 77° F. The laboratory records of the city show streets on which the penetration varied from 65 to 129 and from 62 to 123.

Among the asphalts which have been furnished is the Cuban asphalt, which has not heretofore been considered by some asphalt experts as a satisfactory material for street pavements. The chief reason for its limited use has been that it possesses many of the characteristics of the grahamites, such as great hardness and high melting point, small loss by distillation at high temperatures, high content of inorganic matter, low percentage of bitumen soluble in naphtha (often called petroline), and a high fixed carbon. Another objection is the very large percentage of residuum oil that must be used to make a paving cement of the proper consistency. A good pavement may be laid with this material if compounded and used under the direction of a scientific expert, but poor results are likely to follow where only the knowledge and skill of the ordinary paving contractor are available.

As delivered on the street, surface mixtures usually appeared to be of satisfactory composition and well mixed. The asphalt plants now in operation in the city are capable of turning out good work. An examination of the sands used at the various paving plants indicated that in some cases they were not being properly graded.

CHARACTER OF THE WORK.—The methods used in the work of laying and manipulating the mixture on the street, while not violating express provisions of the specifications, nevertheless often were open to criticism in several respects. A large proportion of the work, moreover, has not conformed to the requirements of the specifications.

The inspection of numerous pavements being laid in Chicago during October and November, 1910, disclosed the facts that, while the binder mixture was fairly good in most cases, there was generally a lack of the finer-sized stone and sand, and the binder was not laid with sufficient care. The raking was more or less careless and the rolling nearly always was deficient. Where rolling is insufficient, the binder is left soft and spongy, and during the hot weather it may yield under the wheels of heavy vehicles and cause settlement in the surface course. On 49th St. the binder was being laid at a temperature of about 180° F., which is not in accordance with the specifications. At this temperature the binder, when laid on cold concrete, is likely to chill before it can be properly raked and compressed.

The specifications require that the asphalt shall leave the plant at temperatures ranging from 250° to 325° F., but no provision is made for a minimum temperature at which the mixture shall be laid on the street, this being left to the judgment of the contractor and inspector. Under favorable circumstances, the wearing surface should arrive on the street at a sufficiently high temperature; but it was found too cold in several instances when tested. When laid under such conditions, proper compression is impossible, honeycombing develops, and a porous pavement is the result. The surface also is likely to become irregular.

The maximum and minimum temperatures at which binder may be laid are now specified, and it would seem desirable that limiting temperatures for laying asphalt should also be definitely stated. The limits might be fixed at temperatures between 235° and 335° F. Each inspector on the street should be furnished with a thermometer to test the material.

As a general thing, the rolling of the wearing surface as well as the binder has been insufficient. All authorities on the subject are agreed that thorough rolling is necessary to produce satisfactory asphalt pavement. If the wearing surface is not thoroughly compressed before it becomes cold, it will thereafter remain more or less soft and spongy, will absorb a larger percentage of water, and will be inferior in wearing qualities. A very slight difference in the final density of a pavement makes a great difference in its ability to endure heavy travel. The light roller should be used on the surface mixture as soon as possible, and the rolling continued with the heavy roller until the material has received its maximum compression.

The city specifications cover many of these points and, if enforced, would insure good results. Directions for the placing of the surface mixture, set forth in the city specifications as follows, should be rigidly enforced:

> Upon the arrival at the street it shall be dumped at such distance from the work that all of the mixture must be turned and distributed to the place where it is to be raked. It shall be spread while hot upon the asphaltic concrete binder, which must be thoroughly dry, free from dirt, leaves or other foreign matter. The last load of the day shall be spread at least one hour prior to the official time of sunset. After receiving its ultimate compression by rolling, it shall have a thickness of 2 ins. The initial compression must be effected by means of a small roller, after which a small amount of hydraulic cement shall be swept over the surface. The final compression shall be effected by a 10-ton roller, or the equivalent, of not less than 250 lbs. per running inch width. Rolling must be steadily kept up and continued until all roller marks disappear and the surface gives indication of no further compressibility.

ECONOMY IN ASPHALT PAVING.—It is now generally conceded that, where a binder is used, the binder course should be 1½ ins. in thickness; but the thickness of the wearing surface may be varied with advantage to suit traffic conditions. For the heavier traffic streets, 2 ins. of surface mixture is desirable; but for light traffic streets, or streets entirely residential in character, a surface layer of 1½ ins. would meet all the demands of traffic equally as well and could be constructed at less cost.

For light traffic streets a pavement may be designed, less expensive in character than that used on heavy traffic streets. This would have ample strength to carry the occasional coal wagon or moving van and, not being subjected to the continual blows from heavy trucks, would have fully as long life as the heavy pavements now used. The latter construction consists uniformly throughout the city of a 6-in. Portland cement concrete base, a close binder of 1½ ins., and a wearing surface 2 ins. in thickness—a total thickness of 9½ ins. For the lighter traffic pavement it is suggested that a 4-in. concrete base, a 1½-in. binder and a 1½-in. top be used, making a total depth of 7 ins.

About the same reduction in cost may be obtained by constructing a pavement with a 6-in. Portland cement concrete base, painting the surface with asphaltic cement, and then using a 1½-in. wearing surface without a binder course. For such a pavement a thin coat of mortar might be spread over the concrete before the course has set, so as to obtain a smooth surface for the paint coat. Careful consideration should be given to this type of construction. The bituminous concrete pavement with its wearing surface laid directly on the concrete has demonstrated the fact that a binder is not really necessary. For streets of very light travel a 4-in. concrete base would be sufficient and would effect a further reduction in cost.

Other Paving Work.

BRICK PAVING.—The requirement for lugs or raised letters on the brick is of no advantage, particularly when a bituminous filler is used. If the brick are carelessly laid so that the lugs face each other, a large joint is made and, with a ¼-in round corner, a space of ⅜-in. is left between the tops of the arcs on the corners. Bricks with lugs increase the cost of laying by requiring greater care and a larger amount of filler. Bricks without lugs are usually rough enough to provide sufficient space for the filler, and they make a smoother pavement when closely laid.

The specifications require that all brick shall be delivered to the layer on pallets or by means of roller conveyors, not wheeled with barrows or dumped. This is a proper restriction, but it has not always been observed. They provide for a minimum lap of 3 ins., but frequent instances were noted where the lap amounted to but 1 or 2 ins.

No squeegeeing of any bituminous filler is permitted by the specifications, but practically this method was employed in some cases. There is no reason why all contractors should not be required to pour the filler through spouts. To do this, it must be heated to a proper temperature to work satisfactorily. With the squeegee method, fairly cold tar can be spread over the brick and the joints will seem filled when there is only a thin surface coating.

The edges of the brick are better protected by a cement grout filler than by a bituminous filler.

GRANITE BLOCK PAVING.—In some cases the blocks were not laid as closely as they could be, nor as the specifications required (with a maximum joint space of ⅜-in.) The specification requires a minimum lap of 3 ins., but in some places the joints were almost continuous, or with a lap of only 1 or 2 ins.

The present method of completely filling the joints with gravel makes it difficult to fill the voids with coal tar, and as a rule only about ⅝-gal. per sq. yd. is being used. The better way, where bituminous joints are used, is to fill the joint only about half full with gravel before the pavement is rammed, and then completely fill the voids thereof with coal tar. The upper half of the joint should then be similarly filled with gravel and saturated with coal tar. This method of filling would require about 1¾ gals. of coal tar per sq. yd., but all of the voids would be filled.

Portland cement grout is less expensive and many paving experts now concede that the latter also forms a better joint filling for granite pavement. Where the joints are thus properly filled with good cement grout, the paving stones are held in place with great firmness and the whole pavement becomes practically a monolith. The cement filler with closely set granite blocks has been adopted by a number of American cities, and wherever used is giving very satisfactory service.

SUBGRADE.—The inspectors of this Bureau noted instances of plowing below subgrade. This should be prohibited. The specifications should require that the last 2 or 3 ins. of subsoil should be loosened with picks, and they should also prescribe the weight of the roller to be used for rolling the subgrade. The present specifications leave the contractor free to prepare the subgrade as he wishes.

CONCRETE.—The present requirement of batch machine mixers and the frequent adoption of a one-bag batch, which permits the use of the original bags of cement, are to be commended, as they eliminate to a very large degree intentional or other variation in the quality of concrete. It was observed that on two or three streets the concrete contained an excess of water. The specifications require that the concrete be thoroughly rammed, and evidently do not contemplate so wet a mixture.

The practice of brushing over the surface of the concrete with a street-sweeping broom should be discontinued. This only can be of advantage to the contractor in plastering over and concealing defective work. The men employed at such sweeping should be put to tamping, because, as a rule, the concrete was not found to be sufficiently tamped. Even where the proper number of tampers were employed, observation showed that they were not doing effective work.

The specification for limestone screenings states that they "shall be of sizes ranging from ¼-in. down to the finest, and shall be free from dirt, dust and other impurities." A large percentage of the stone observed was too nearly uniform in size, and most of the screenings inspected contained a large percentage of dust. Moreover, the specifications require that when materials are delivered on the street they shall be stored on clean pavements or temporary plank floors. This is rarely done.

Changes to Effect Economy.

A direct annual saving, estimated at not less than $200,000, may be effected by modifying the present specifications for asphalt and wood-block pavements to conform to traffic conditions. Pavements on light traffic streets are constructed now of the same thickness as pavements on heavy traffic streets. When asphalt is used on light traffic streets a 4-in. concrete base and 1½-in. asphalt top would suffice instead of a 6-in. base

and a 2-in. top, as now required. When wood block is used on light traffic streets, a depth of 3½ ins. would answer, instead of 4 ins., which is now required.

INSPECTION.—The fact that numerous cases of defective work were discovered by the Bureau's investigators indicates that the city inspection is in many ways very ineffective. In order to insure compliance with contract requirements, the inspection service must be made much more vigorous. Great precaution should be taken to guard against laxity in the enforcement of the specifications, whether from ignorance on the part of the inspectors, or from carelessness, or from collusion with contractors. While it is highly important that specifications be properly drawn, it must be recognized that the weakest spot in the city paving system at present is the inspection of the contractor's work. This deserves careful attention on the part of the responsible authorities. More may be done to lengthen the life of the pavement and secure economies in the actual cost by establishing effective inspection than in any other way.

(2) MR. MOHLER'S REPORT.

This report (to the Loop Protective and Improvement Association) deals with a number of matters relative to paving work, besides the main subject of wood block paving. In regard to concrete foundations, it recommends that the use of limestone screenings instead of sand should not be permitted; the principal reasons given are that such material furnished in Chicago contains a high percentage of dust, is apparently the product of a very soft stone, and has a decided tendency to form lumps (even when dry). The local gravel is considered to make a better concrete than the crushed limestone commonly used, but recommendation is made for the use of torpedo sand and crushed granite or trap rock. The surface of the foundation should be so finished that elevations and depressions do not exceed ¼-in. above or below the established grade for this surface. For the sand cushion a thickness of ½-in. is recommended, with sand not too fine in size. Bedding the blocks in cement mortar (instead of sand) is also noted, and it is stated that where this has been done for blocks laid against the outside of the street car rails there has been little settling or rutting.

Creosoted Wood-Block Paving.

Mr. Mohler states that this comes nearer to the ideal pavement than any other material, but is more or less slippery during winter and at times when wet in warm weather. As to the kind of wood, he considers that almost any sound wood with the required crushing strength may be expected to give good results when properly seasoned, treated and laid. He favors the use of oil of high specific gravity and impregnation of the wood with as much oil as it will carry, although it has been pointed out that such heavy impregnation is liable to injure the wood; and to use an excess beyond what is required for preservation must be uneconomical. He admits that this will increase the "sweating" of the blocks in the street, but is inclined to make light of this objection.

As a matter of fact, we may interject, this condition is a great nuisance in Chicago and has been the cause of considerable complaint and prejudice against the paving. He suggests in different parts of his report that the condition may be remedied in different ways: (1) by spreading sand over the surface when necessary, (2) by scraping off the greasy coating, and (3) by rolling a layer of gravel into this coating so as to form a protective wearing surface.

These appear to us to be very makeshift and impracticable methods of dealing with a condition which should be prevented rather than cured. Furthermore, they would involve expense and cause more or less interruption to traffic. It is hard to consider the third method seriously; the objectionable coating is not uniform in location or thickness; in most places it is thicker at the sides, the crown of the street being comparatively clean. Consequently, the street would require a coating of pitch or similar material to receive the suggested sprinkling of gravel. We quote below some of Mr. Mohler's remarks as to wood-block paving.

The amount of creosote oil called for by the Chicago specifications is 16 lbs. per cu. ft.; some cities require from 20 to 22 lbs. My judgment would be in favor of the larger amount or all that can be forced into well-seasoned timber under the best method of treatment. The reason for the higher degree of impregnation is to exclude water or moisture to the greatest degree possible. That should be done for two reasons: (1) with the absorption of moisture the blocks swell, and then shrink when dried; (2) wood has much greater crushing strength when well seasoned and dry than when damp or wet.

If the blocks absorb too much water there is danger of their swelling to the extent of bulging the pavement. When soaked with water (or even damp) the blocks become soft and will crush and broom under traffic much more readily than if thoroughly dry. A wet block will have about half the crushing strength of one well seasoned and dry. That is probably why the destruction of wood block pavement is comparatively rapid when rutting and brooming is once started. For heavy traffic streets a much lighter charge of preservative would be effective if only provision against decay were required. With the heavy charge of oil there will be more of what is termed sweating or bleeding (oil oozing from the blocks).

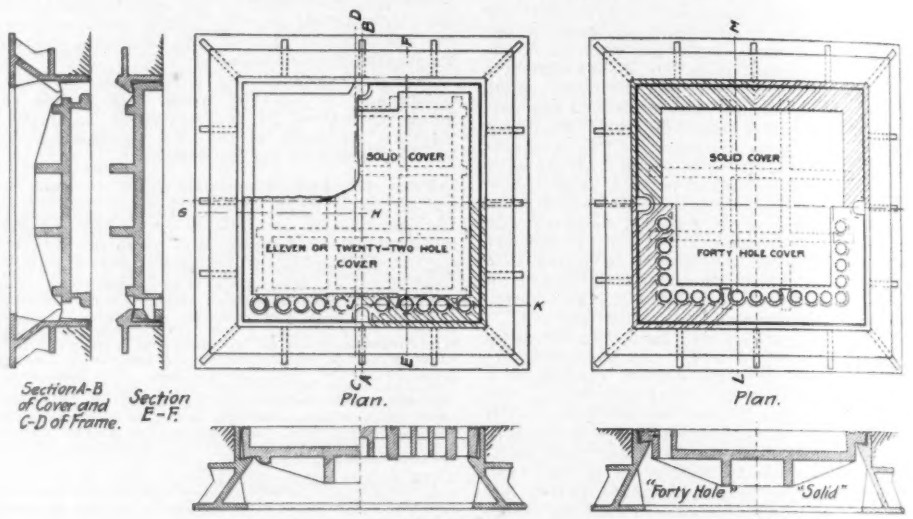
Longitudinal and transverse expansion joints have been commonly employed when the blocks were laid on a sand bed with sand filler to prevent bulging when the blocks become heated or water soaked. To my mind transverse (and possibly to some extent longitudinal) expansion joints are objectionable for two reasons: (1) If the joint closes up, the rows of blocks on each side usually are pushed up enough to form a ridge across the roadway; to this rise in the blocks is added the pitch that is squeezed out of the joint; (2) if the joints do not close up, then the pitch is gradually worn out from between the rows of blocks and a rut left the entire width of the roadway. This is subject to rapid wear by calks of horses' shoes and pounding of wheels on the exposed edges of the blocks.

When the blocks are set in mortar, expansion joints cannot be introduced. When used in connection with the sand bed, there is the objection that, when adjoining blocks of different height are brought to an even top surface, the bedding of the blocks may be too much disturbed when the blocks can move laterally. On account of the arch or crowning of the roadway cross-section (from which heaving may result when expansion takes place), and from the fact that the longitudinal expansion joints are in the gutter and subject to little wear, there is more reason for and less objection to their use than there is for transverse expansion joints.

The aim should be to get the blocks so laid that they will remain exactly in the position in which they are placed regardless of traffic movement, weather conditions, or temperature changes.

Sand filler for the joints has been used on a number of the downtown Chicago streets. Owing to the fact that sand filled joints allow free access of water all around the blocks and that sand has no elasticity, I do not believe sand is a desirable material. There may be some advantage to be derived by the use of a pitch and sand filler. That method would consist in filling the lower half of the joint with pitch to give a water-tight joint, and the upper part with sand to take up the excess of oil or pitch to give a cleaner surface.

The pitch filler is the element that is in a large measure responsible for the dirty and objectionable features of block pavement in hot weather.* The condition is usually aggravated when damp weather prevails. It is believed that an asphalt pitch might be used to advantage over tar pitch. It does not get soft and flow as readily in hot weather and does not get as brittle in cold weather. It also has the added advantage that it does not stick to the feet and track about like tar pitch. Pitch filler should obviate any possible demand for transverse expansion joints, and possibly longitudinal as well.



PROPOSED DESIGN OF WOOD-FILLED MANHOLE COVER FOR STREETS PAVED WITH WOOD BLOCK.
(C. K. Mohler, Chicago, Designer.)

Paving of Street Railway Tracks.

The use of granite-block paving for the street car tracks is objected to by Mr. Mohler on account of the noise. He believes that there should be a uniform pavement over the entire width of the roadway; if this cannot be secured, at least the granite blocks on the outside of the rails should be removed and the wood blocks laid against the rails. Irregularities in the surface of the paving are considered due to the vibration of traffic causing the sand of the cushion bed to work into voids in the concrete and the open spaces not properly filled beneath the rails. As a remedy for this he proposes a mortar finish for the concrete base and the use of a thin cushion bed, or possibly using a mortar bed for the blocks along the rail. This last plan has been used in some cases, with good results, as noted above. It may be noted, also, that several streets in the downtown district have the tracks (as well as the sides) paved with creosoted block; this is done, however, by arrangement with the property owners.

At track intersections and switch connections it is difficult to make a good surface. The guard side of the straight rail is ¼-in. lower than the head, and on the special curved rail it is ⅝-in. above the head.

The report makes a strong point against the form of rail section used in Chicago, in which the outer part of the top of the head is beveled off so that the vertical part of the side of the head is ⅝-in. below the top. If the paving is laid flush with the top of the head of the rail, there is formed a groove which holds water, while the unsupported edge of the paving blocks is liable to be crushed and broomed. If the pav-

*This statement is disputed in the preceding report.—Ed.

ing is brought up to the lower edge of the bevel, the rail forms an obstruction in the paving. A novel arrangement of tie rods is suggested, as quoted below.

The paving between the track rails is subject mostly to the action of horses' shoes. This is especially aggravated at points where the tie rods are located. It is believed that more satisfactory results might be had if the tie rods were turned flatwise and thoroughly bedded in mortar so as to form a part of the paving bed. With a 2-in. or 3½-in. paving block, the tie-rod space could be eliminated by laying the blocks continuously over the tie rods. The depth of blocks used in track paving in New York is 3 ins.

As the greater portion of the wear in the track paving comes from the horse shoes and at the transverse joints, laying the blocks lengthwise of the track would reduce the number of transverse joints fully 50%. In addition, those that do occur would be broken. I know of no case where these expedients have been tried.

When the blocks are laid in diagonal courses it is desirable that the joints against the rails be as close and even as possible. That can best be had by the use of saw-cut ends. When the blocks are split by hand they are rarely at the true bevel. Then again the grain is not always at right angles to the top face, the split edge giving an open joint either at the top or bottom of the blocks. Splitting produces more waste in the blocks. One long block sawed on the diagonal in the middle will give two beveled blocks without waste. With the ordinary method of splitting the bevel cut from the end is wasted. I am informed that one firm proposes to furnish blocks sawed to the required bevel.

Manholes and Pipe Galleries.

MANHOLES.—The report refers to the objectionable number and shape of manhole frames and covers in the pavement and suggests a uniform style for use by the city and the several public service corporations. A design is presented for a cover having a filling of wood blocks, in order to avoid the noise and shock of vehicles crossing the ordinary iron covers. This is shown in the accompanying cut, and the remarks as to manholes are quoted below. When manholes at street intersections are opened they block traffic on both streets; when those in streets having elevated railway columns in the roadway are open they entirely block the side roadway and throw traffic back upon the street car tracks (in the space between the columns). It is recommended that new manholes should not be located at intersections, and that in streets obstructed by railway columns new manholes should be located near the curb, where they are in line with standing vehicles and leave an open roadway between these and the columns.

The manhole cover is designed to be set with creosoted wood blocks to form the wearing or roadway surface. There are two types shown, embodying the following features:

(1) The deep seat cover. With this arrangement the cover seat is well down in the frame, allowing the cover to rest on its base. That allows the maximum amount of surface to be set with wood block. With a solid cover only about 1½-in. width of cast iron is brought to the surface, around the outside of the cover.

(2) The shallow seat cover. In this, the cover seat is near the top of the frame, the cover rests on a flange outside of the recess wall and the cast iron surface surrounding the outside of the cover comes to the road surface, being a little over 3 ins. wide for a solid cover. This type will be less liable to freeze down in winter. It can be adapted so that new covers can be set in old frames.

For both types, ventilating holes are provided where necessary. Instead of being at the center, as in the recessed asphalt-filled covers now in use in some of the boulevard roadways, they are placed around the outside edges, so as to leave the wood-block surface continuous. With the deep seat cover and ventilating holes the cast iron surface is about 5 ins. wide. With the solid covers the two bar holes would give a small amount of ventilation. If greater ventilating area is required, one or more sides of the cover can be provided with holes.

Recessed covers filled with asphalt are being used to a considerable extent on some of the asphalt paved boulevards, as previously noted. Under the heavy traffic conditions of the downtown streets it has not shown the requisite amount of durability.

PIPE GALLERIES.—There is urgent need to dispose of the pipes and wire cables of the city and the different public service corporations in such a way as to eliminate the necessity of the street being torn up at any and all times. The city and public service corporations have adopted a policy recently which is a vast improvement over the old methods. When a street is to be repaved the different corporations are notified to get their work completed in the street before the city lays the new pavement.

There has been formed something in the nature of a committee, consisting of a representative from the city and one from each of the public service corporations. Through this committee the order of the work is so arranged that there is little or no conflict in the execution of the work to be done. The work is usually all completed before the paving is laid down. Nevertheless, with the great number of utilities having underground street occupancy, and the rapidly growing demands, many of which cannot be foreseen, the street is hardly safe from invasion at any time.

Two New Rail Joints for Street Railway Track.

Street railway track construction often permits of the use of special types of rail joint owing to the fact that the rails (being buried in the paving) are protected against extremes of heat and cold, so that expansion may be practically neglected. Furthermore, there is very generally a rigid and substantial concrete foundation for the track, while a joint that will require a minimum amount of maintenance work is necessitated by the impracticability of continually adjusting the joints (covered by the paving) as is done on open track construction. Two forms of joints designed specially for track of this class are described below.

THE JONES BEVELED JOINT.— The essential feature of this joint (Fig. 1) is that the rail ends are cut at an angle with the plane of the base, instead of being vertical. Its special purpose is to keep the adjacent rail heads in the same horizontal plane when under load. On double track the slope is against the direction of travel. It is claimed that in this way the end of the receiving rail is supported by that of the leaving rail, so that the former can have no vertical drop, which would result in the "cutting out" of the receiving rail a few inches beyond the joint by wheels jumping. Of course the vertical play, which is assumed to be increased by the cutting of the tie under the receiving rail (due to the impact upon the rail), may be prevented by the use of a tie-plate on the joint tie. The joint has given very satisfactory results in extended service, but it is a question how much of the efficiency is due to the inclined cut of the rail ends, and how much is due to the base support and well-fitted splices.

As the inclination from the vertical is only about 1 in 6 it is evident of course that the actual bearing support of one rail by the other is very slight. Indeed it will not exist unless the rails are butted together in tight contact and are held rigidly and permanently in contact by the splice bars. The slightest separation of the rails would eliminate the support, unless the receiving rail is depressed, which movement is exactly what the joint seeks to avoid. For this reason the cuts should be made accurate and smooth, and the rail ends brought close together. It is recommended also that the bolt holes nearest to the ends of the rails should be spaced 3/16-in. further apart than the corresponding holes in the splice bars, so as to allow for the usual difference in diameter of the bolt and the hole. The joint is made with the four holes in the splice bars 5 ins. c. to c., while the two middle holes of the abutted rails are 5 3-16 ins. c. to c.

In splicing the rails, the splice bars are bolted first to the receiving rail (A, Fig. 1). Then a drift is placed through the bars and the end hole of the other rail (B) and while thus held, a bolt is put through the fourth hole. The drift is removed and the last bolt then placed in the third hole. It is necessary to have the bolt holes

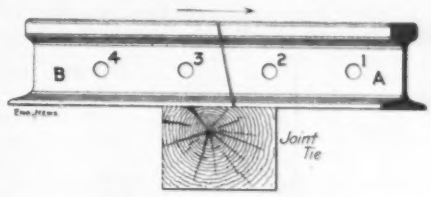


Fig. 1. The Jones Beveled Splice Joint; Denver City Tramway Co.
Duncan Bond, Denver, Colo., Owner.

accurately spaced and the bolts and holes finished to the sizes specified. The patent covers the cutting of the rail ends and any form of splice may be used.

This joint was first used by the Denver City Tramway Co. in 1904, and in 1909 over 15,000 joints were in use. It is now the standard rail joint on this system, and has been tried by other lines. It was invented by an experienced track foreman (now dead), and is sold by Mr. Duncan Bond, Exchange Building, Denver, Colo.

THE GAILOR WELDED JOINT.—Welded rail joints have been used extensively in street rail-

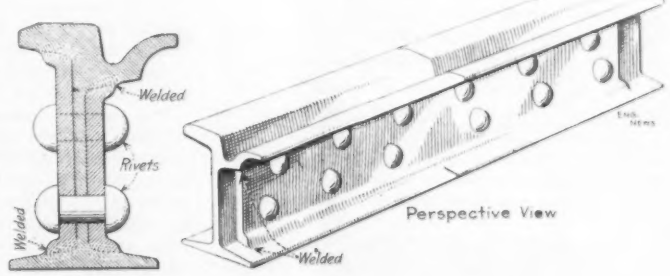


FIG. 2. THE GAILOR WELDED AND RIVETED JOINT.
C. F. Gailor, Hartford, Conn., Inventor.

way track construction, and the Gailor method applies it in a new way to riveted splice joints, which have been used in several cases. In cast-welding the two rails are welded together to form one continuous rail. In electric welding, splice bars are welded to the webs of the rails, as described in our issue of Sept. 1, 1910 The use of riveted splice joints has been found satisfactory on lines in Philadelphia (Nichols joint), Cleveland (Clark joint) and Brooklyn, N. Y. Mr. Gailor proposes to supplement the rivets by welding the top and bottom of the splice bars to the heads and flanges of the two rails, thus not only making a rigid joint but securing such electric conductivity as to obviate the necessity of using separate rail bonds. In addition it eliminates the difficulties due to wear between the contact surfaces of the rails and splice bars, and ensures maintaining the running surface of the rail heads in the same horizontal plane. The construction is shown in Fig. 2.

The riveting is done first by a powerful compression riveter, which gives such continuity and close contact of the parts as to provide sufficient conductivity (in the newly riveted joint) for the passage of the electric current. The welding is then done by means of an electric arc, the current for which is generated by a simple apparatus designed to produce an arc of intense heating property. This arc is applied to the edges of the splice bars and rails, and specially prepared metal is then fed into the heated area by apparatus designed for the purpose, so as to fill all voids and spaces between the contact surfaces.

This joint is the invention of Mr. C. F. Gailor, Hartford, Conn., who is Roadmaster of the Hartford lines of the Connecticut Co. (operating the electric railway properties of the New York, New Haven & Hartford Ry.).

Automatic Electric Motor Control by a Novel Magnetic Switch.

It has long been realized that purely hand regulation of current input to a motor, without a skilled operator, leads either to unsafe currents on one hand, or excessive loss of time in starting on the other hand. The automatic regulation of current has been aimed at but secured heretofore

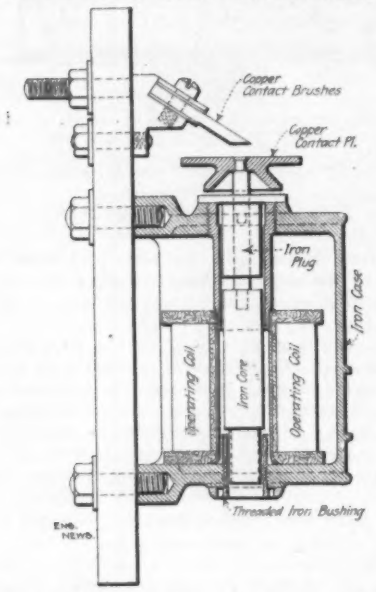


Fig. 1. Section Through Automatic Magnetic Switch (The Electric Controller & Supply Co., Cleveland).

only by an expensive and delicate aggregation of apparatus, involving sensitive relays. Some success has been secured in building rugged current-limit relays for electric-railway controls, but they have not been otherwise widely applicable.

A new type of magnetic switch has recently been put on the market which has the peculiar ability of (1) closing only when the current is below a predetermined value, (2) remaining closed, after once closing, until the current drops nearly to zero. With several such switches, it is evident that the starting resistances can be gradually and automatically cut out; at the same time loss of line voltage would cause the starting resistance to be put back into circuit ready for automatic starting when voltage should be restored. All that the operator would have to do in such a case would be to close a main switch to start his motor and to open it for stopping.

The following description of the switch in question follows that of Mr. A. C. Eastwood in a paper before the American Institute of Electrical Engineers, at Chicago, June 26, 1911. In the cross-section of Fig. 1, the contact plate is attached to the iron core of a coil by a non-magnetic stud passing through the magnetic plug above the core. The winding is carried on a brass sleeve within which the core is free to rise and fall, carrying with it, of course, the contact plate. The diameter of the lower part of the core is stepped down to form a shoulder where the core passes into an adjustable plug or bushing of magnetic metal. The semi-cylindrical casing which encloses the winding forms the return path for the magnetic flux of the coil. When current flows in the coil, the magnetic flux set up passes between the upper face of the core and the plug above it. This flux is all practically normal to the face of the core end and effective in producing a force tending to close the switch. It is seen that there are two paths for the flux at the lower end of the core (1) from the horizontal base of the enclosing frame into the bushing and up to the shoulder face of the core, and (2) from the frame through the bushing into the reduced section of the core. Flux taking the first path produces a pull tending to shorten the magnetic circuit and opposing the pull developed at the upper face of the core. Flux taking the second path produces no force on the core in a vertical direction. The small end of the core is shown hollow, giving a small cross section, the magnetic reluctance of which increases with increase of flux.

The core then experiences (1) a magnetic pull upward tending to close the switch, (2) a magnetic pull downward, reinforced by the weight of the core, contact plate and stud, tending to open the switch contacts. The parts are so proportioned that the upward pull is greater than the entire downward force if the current is below a critical value. Above this point, the downward magnetic pull plus the weight exerts the greater influence and the switch fails to close. This is possible since at light current most of the magnetic flux passes directly across the lower-end bushing into the core, while at heavy currents it is forced into the air-gap path by the increasing reluctance of the core end. The critical point to which the current must drop before the switch will close can be adjusted by screwing the bushing in or out to change the length of lower air gap. Screwing the bushing in to decrease the air gap lowers the critical value of current which must be reached before the switch closes. The range of such adjustment is indicated by the typical diagram, Fig. 2. The switch, to which this diagram applies, with the bushing at position "a" would "lock out" (remain open) until the current fell to 200 amps. and, once closed, would "lock in" (remain closed) until the current fell to 50 amps. With the bushing at position "b" the lock-out point would be 300 amps. and the lock-in at 35. After the switch has once closed the magnetic circuit is a substantially closed one and the core will not drop until the current is very greatly reduced, corresponding in practice to loss of line voltage or open circuit.

Fig. 4 shows, diagrammatically, the arrangement of these switches as a simple starter for a compound-wound motor having the armature "A," series field "F" and shunt field "f." The simple single-throw double-pole switch "K" is closed by the operator at starting and opened for stopping, this being the only mechanism which the operator handles. "S_1," "S_2" and "S_3" are three of the automatic switches described, connected so as to short-circuit the starting resistances "V_1," "V_2," "V_3." The actuating coils "C_1," "C_2," "C_3" are series wound. The switch "S_3" has a shunt-wound (high-resistance) holding coil which comes into action only when this switch closes. On closing the switch "K" the shunt field is connected across the line and current flows also through the armature, series field, entire starting resistance and the operating coil of "S_1." The motor should then start but the switch "S_1" will remain locked out until the starting current has dropped to some predetermined value. Then the contact plate rises and the resistance section "V_1" is short circuited by the series coil "C_2." When the current again drops to the desired figure, this switch in turn short circuits the resistance "V_2" with the coil "C_3." The last section of resistance finally is cut out by the switch "S_3." It will be seen that when "S_3" closes it deprives all three operating coils of current and would itself open were if not for the shunt holding coil. Fig. 5 shows the accelerating curve of a 5-HP. compound-wound motor driving a punch press, three automatic switches being used.

In general three such switches are adequate for motors up to 25 HP., though above this up to six may be required. In any case the number should be limited by the sensitiveness of the switch itself (5% above or below predetermined value). For the smaller motors—up to 5 HP.—starting under light load, or light-inertia load, a single automatic switch is usually sufficient. The self-induction of the motor greatly helps to cut down the initial currents from the values indicated by the resistance steps alone.

Fig. 4 shows the arrangement for a compound-wound motor, but the scheme is applicable to straight shunt or series-wound machines. For series-wound motors where the load is likely to drop off, leading to over-speeding, the holding coil of the last switch of the series ("S_3" in Fig. 4) would be a series coil through which the motor current flowed after closing of this switch. When the current fell off, with speed increasing to a dangerous point, this holding coil would let go and throw in all the starting resistance.

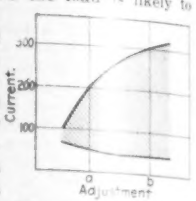


Fig. 2. Operating-Range Curves of Automatic Magnetic Switch.

There is no danger of arcing at the contact brushes of these automatic switches, since they open only under very low current. Opening of the main switch ("K" Fig. 4) under heavy load, however, is apt to cause arcing at this point so that a protected-contact switch may be necessary here.

The main switch may be a shunt-wound, magnetically operated contactor controlled by push-button or pilot switches at convenient points. This sort of control is well adapted to remote control by pressure-gage or float switch or by other device of similar functions. Overload protection may be very easily secured with such control by replacing one pilot switch by a small overload relay.

Various more complicated but still rugged arrangements have been made. For instance, there is a special controller for heavy machine tools, like boring mills, where dynamic braking is desired. This starter has a main switch operated by a shunt coil and also a braking switch similarly operated. The operator controls his motor through "start" and "stop" push buttons. The starting is in the manner already described. When the "stop" push is used the main switch is opened and the braking switch establishes a local circuit across the armature leads. This circuit contains the starting resistance and the coil of the first automatic switch. As the motor

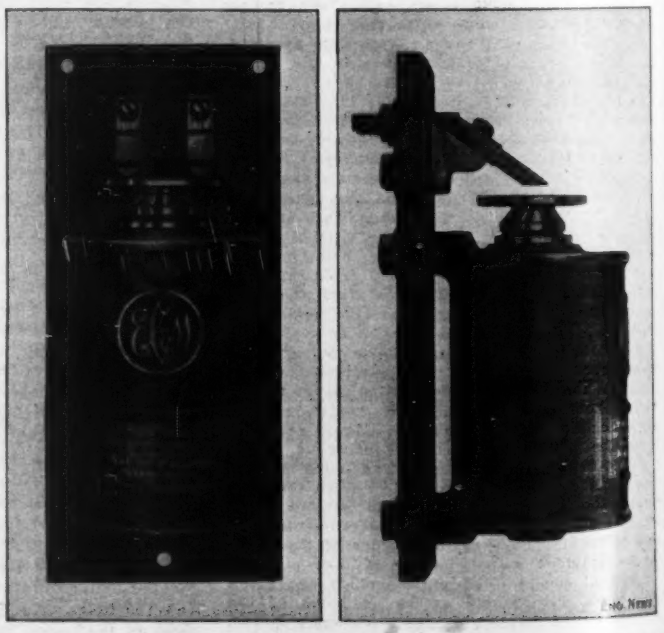


FIG. 3. AUTOMATIC MAGNETIC SWITCH (ELECTRIC CONTROLLER & SUPPLY CO.)

slows down the braking current generated decreases and this switch operates to cut out one section of resistance and cut in the coil of the second automatic switch, and so on. Thus both starting and braking current are held under automatic control to safe limits.

Fig. 6 shows the diagram for a 75-HP. reversing controller for steel mill service. Direction of

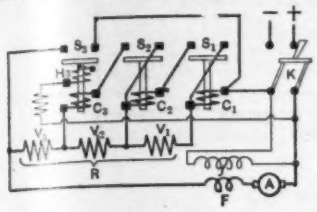


Fig. 4. Diagram of Simple Automatic-Acceleration Motor Starter.

rotation is controlled by the throw of a single lever, one or the other of two electrically operated switches connecting the motor to the circuit. When one switch is closed, action of the other is locked. The automatic cutting out of resistance continues as in other types, at the maximum safe rate. The coils of the automatic switches are somewhat modified and remain in series with the motor when running. Therefore a separate holding coil is not needed on the last switch. For rapid safe reversal, it is essential that all the starting resistance shall be in circuit when the motor connections are reversed to insure that the reversing (magnetically operated) switch is not thrown in before some one of the automatic switches has dropped back. The lockout coils of the reversing switches are connected as shown so as to receive current unless every automatic switch is released. All such desirable features are secured without any small or delicate parts, which are extremely undesirable in steel-mill service. This form of controller gives no speed control; where that is desired it is merely

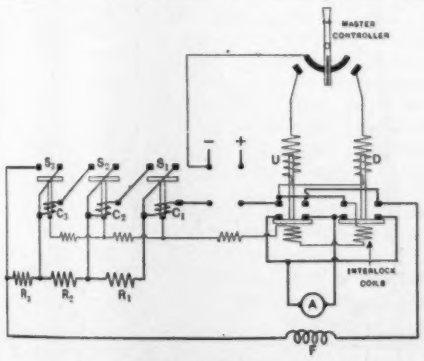


Fig. 6. Without Speed Control.

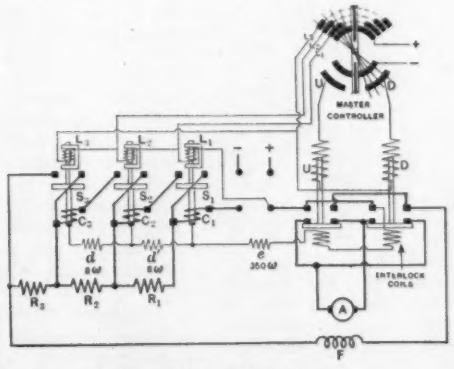


Fig. 7. With Speed Control.

FIGS. 6 AND 7. DIAGRAM OF AUTOMATIC CONTROL FOR STEEL MILLS.

necessary to add "holding-out" magnets controlled by the position of the operator's lever. From Fig. 7 it is seen that the holding-out magnets are successively de-energized as this lever moves toward final position (full-speed). Still there are no objectionable parts or complication to the mill operator.

Federal Funds in Aid of Industrial and Agricultural education are provided by a bill introduced in the Senate by Senator Carroll S. Page, of Vermont, and numbered 3 on the Senate calendar. The bill would provide an annual appropriation of over $12,000,000, of which $5,000,000 would be expended upon instruction in trades and industries, home economics and agriculture in public schools of secondary grade. Four million dollars per annum is provided for state district agricultural schools of secondary grade. An appropriation to amount eventually to $1,500,000 per annum, is furnished to foster extension work by state colleges of agriculture, and $1,000,000 is provided for instruction in the branches above specified in normal schools. The whole amount is to be available for running expenses of the various schools, the land and buildings to be provided by the States themselves.

Water-Main Scraping at Southmolton, England.

Until recent years few attempts to restore the carrying capacity of tuberculated water mains have been made in this country, although the practice has long been common enough in England. We condense from our London contem-

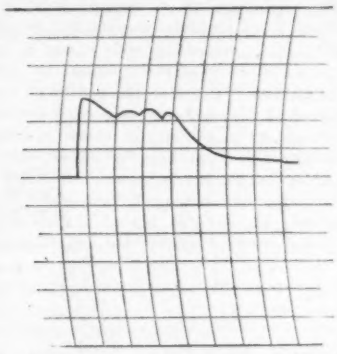


Fig. 5. Acceleration Curve of a 5-HP. 220-volt Compound-wound Press-Punch Motor.
(Full-load current, 20 amps.; running current of test, 6 amps.; average accelerating current, 24 amps.; accelerating time, 9 seconds.)

porary, "The Surveyor and Municipal and County Engineer" for July 14, 1911, an article on pipe-scraping operations at Southmolton, England. The article was written by Mr. E. D. Groves, Engineer and Surveyor to the St. Austell Urban District Council, formerly Borough Surveyor of Southmolton.

The scraping operation reported by Mr. Groves was confined to a small supply main, but that adds interest to the article since it shows that in some places it is considered worth while to scrape small mains.

The water-supply of Southmolton is gathered on a moorland, 1,400 ft. above sea level, and nearly 700 ft. above the storage reservoir, to which the main scraper led. It appears that the main had a total length of about 4½ miles, divided into a 5-in. and a 6-in. section. The 5-in. section extended from the upland receiving reservoir to the service reservoir for a distance of 3 miles and 4,488 ft. The lower portion of this section is 366 ft. below the level of the reservoir. The 6-in. section rises 200 ft. to the service reservoir. The author states that the theoretical discharge of the main figures 204,000 U. S. gals. per day, but after 40 years of service the actual carrying capacity was only 115,000 U. S. gals., due to heavy incrustation.

It was first decided to scrape the 5-in. section of the main, and to that end a contract was made with the Eric Pipe Scraper Co., of Chepstow, England. The machine used is described as follows:

The head of the machine is built up with a series of spring-steel blades in the shape of a cup, which compress to any obstructions on the inside of the pipe; inside the blades is a leather cup which expands to the size of the bore and holds the water, only allowing a small quantity to pass for flushing purposes. The pressure of water drives the head forward, and attached to the head by means of a short rod or piston is the plow.

Owing to the small diameter of the main and the excessive corrosion found in various places, three different-sized machines were used in cleaning the main. The first machine was small and light, the head being built to pass the biggest obstruction, and the plow made light and flexible and intended to remove the outside of the nodules and prepare a passage for the second machine. The second machine had adjustable, flexible plows which could be set to any diameter up to 5 ins., and it was passed through each section of various diameters, as many times as found necessary. The large machine had two sets of heavy plows set out to the full diameter of the pipe, and so constructed as to cover the whole of the internal surface of the pipe. This machine passed through each length once.

Seven hatch boxes were placed in the 5-in. main at from 573 to 4,911 ft. apart. The three machines were passed through the spaces between the various hatch boxes from three to seven times, according to conditions encountered.

The results on the 5-in. section were so good that it was decided to scrape the 6-in. section as well. Accordingly, three hatch boxes were inserted and the scrapers were passed through, using the service reservoir for power.

The increase in the delivery of the main as a whole is not reported by Mr. Groves, but he does give the delivery of the main as measured at a point near the junction of the 5-in. and 6-in. sections. Before scraping, the delivery was about 130,000 U. S. gals. per day, and afterwards it was about 287,000 U. S. gals., or an increase of 120%.

We reprint the last part of Mr. Groves' paper in which he gives some general considerations on the subject of scraping mains:

No hard-and-fast rules can be laid down for pipe scraping, as the unexpected invariably happens. Every care, however, should be taken in the preparation for the work, and nothing should be left to chance. The line of main should first be marked out. If the main passes through fields the line can easily be defined by placing, about 50 yds. apart, sticks with paper fixed on them. Should the main pass along a road or street, the line can easily be marked as previously stated. It is also advisable at every 200 yds., or where it is considered that some difficulty may arise, to expose the top of the main for a sounding-spot. Care should be taken in the selection of suitable positions for hatch boxes; the line of main, gradient, and depth should be taken into consideration, the most important matter of all being to obtain a good wash-out of course to carry away the foul and scouring water. Sluice valves should be fixed directly behind each hatch box to control the supply. A pressure gage should be fixed directly behind the valve. The provision of a pressure gage is most important, as it not only records the static head, but also provides valuable information during the drive, such as variations in pressure, jerky scrapings, sudden hits, and stoppages of the machine and fast runs, all of which should be carefully noted. With regard to the jerky working of the machine, every endeavor should be made to prevent this by the control of the water, but the things most to be feared are the sudden hits and stoppages. These are often the cause of burst mains, and should there be any weakness in any part of the main behind the machine, such hits will find them out. In the description of the work already carried out I have mentioned the difficulty experienced when the machine encountered a badly-made joint. This one obstruction caused a burst main on three separate occasions. Such obstructions may not be met, but it is as well to provide for them by the fixing of a good release or safety valve.

Every care should be taken before commencement of scraping operations to note all bends or deep cuttings on the main or fittings, such as sluice and air valves and ball hydrants. Where air valves or ball hydrants exist, it is better to put them out of action by bolting down a blank cap and rubber washer, otherwise the shock occasioned by the ball being suddenly brought into action as the machine passes may cause the bursting of the main.

Special care should be taken where the main is deep to catch the sound of the machine working and locate its position. Where the main has been 8 ft. to 10 ft. deep I have experienced no difficulty in doing this, if the sounding-men are placed about 3 yds. apart, lying on the ground.

Pipe scraping under its best conditions is trying work for the one in charge, and especially so when the section to be dealt with forms the main supply to a town. Work should be started with the lark, with the hope that it may be finished before sunset, with a constant thought for the unforeseen difficulties that may appear when least expected.

A 150,000-Gallon Reinforced-Concrete Tank, Savannah, Ga.

By P. A. FELLOWS.*

An excellent example of modern reinforced-concrete construction is found in the high service water tower recently completed by the Central of Georgia Ry. Co. at Savannah, Ga. The structure is made up of the supporting tower and two tanks, the upper compartment having 100,000 gals. capacity and the lower one 50,000 gals.

The tower consists of a hollow, chimney-like shaft 188 ft. high, 35 ft. outside diameter at the ground line, with a taper which gradually diminishes until at a height of 75 ft. the shaft is 25 ft. in diameter and continues cylindrical from that point to the top. The tank bottoms consist of domes of reinforced-concrete forming partitions in the shaft. The roof is conical and also of reinforced concrete.

The whole structure rests on a pile foundation consisting of 117 pine piles 40 ft. long driven 3 ft. c. to c. in three concentric circles. The piles were cut off at an elevation of 3.75 ft. above sea level, which is below the line of permanent moisture. The concrete in the foundation was poured around the piles without the usual decking, but care was taken to see that the mass was so reinforced that the load would be distributed uniformly on the piling. This foundation reinforcement consists of ¾-in. corrugated bars laid both radially and as concentric circles. Six of these circular lines of reinforcing rods are close to the outer edge of the foundation and grip the piles so as to prevent any tendency of the foundation to spread outward. Seven other circles help the radial reinforcing to distribute the pressure entirely over the foundation. The radial reinforcement of the foundation is made up of 300 bars 10 ft. long laid in a horizontal position 2 ins. above the tops of the piles and spaced 6 ins. at the periphery.

The foundation tapers rapidly to meet the shell of the tower just below the ground level. This shell is 9 ins. thick at the ground line, diminishing to 7 ins. thick at a height of 75 ft. and continues thus for the remainder of the height of the tower. This shell is reinforced vertically with ½-in. corrugated bars placed near the center of the wall and spaced 24 ins. apart. The horizontal reinforcement is made up of ½-in. rods laid in a spiral, the pitch of this spiral being 1 ft. for each complete circumference. The horizontal rods are wired to the vertical rods at every intersection and all points are lapped 24 ins.

The domes which form the bottoms of the two tanks are also reinforced with ½-in. rods and an extra amount of reinforcing is used in the portion of the shell which forms the walls of the tanks and is thereby subject to hydrostatic pressure.

The tower is lighted by 8 × 30-in. windows arranged in the form of a spiral, each window being 8 ft. higher than the one preceding and 20° in advance. In each of these window openings a pane of double thick glass has been placed and securely plastered with neat cement mortar. Three large windows and a panel door have been provided at the bottom of the tower to make that portion serviceable as a storage room.

The riser pipes are carried up inside the tower and directly through the bottoms of the tanks. Access is had to the tanks by an iron ladder which runs on the outside of the tower from the bottom to the top and extends down on the inside to the bottom of each tank. Openings are provided at three places along this ladder with platform and guard rail to permit safe passage in and out. The first opening, about 75 ft. above the ground, is at the level of the fire alarm bell and its electro-mechanical striking apparatus. The second opening is just below, and the third just above the 50,000-gal. tank. In addition there is a door through the roof to the 100,000-gal. tank.

Waterproofing was used on a part of the tank but dependence was placed principally on the richness of the mixture used. It was not expected that the tank would be absolutely water tight at first, but that the leaks would gradually take up and ultimately cease without further attention. Barring one or two places in the dome-shaped bottoms, where imperfect bond seems to be the cause of the leaks, the result has been exactly as expected. The exceptions noted are very slight leaks and seem to be gradually stopping. There was no marked difference where waterproofing was used. At the time of construction precaution was taken to prevent leaks between successive courses by inserting sheets of galvanized iron in the center of the walls and projecting about 6 ins. into each course.

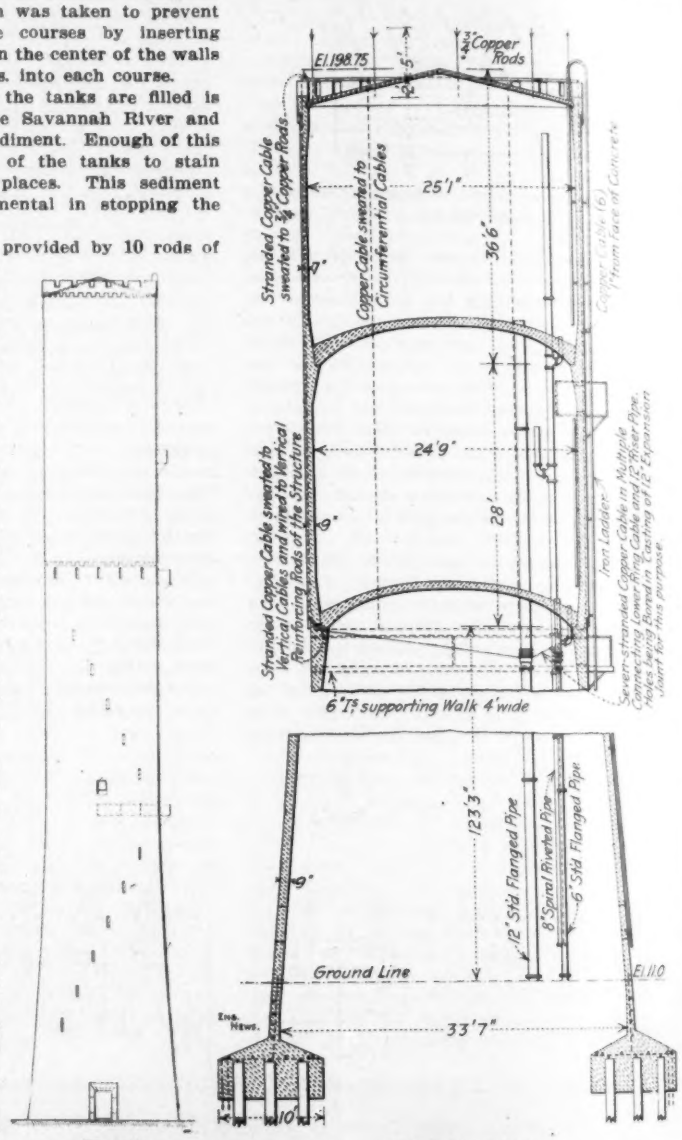
The water with which the tanks are filled is pumped directly from the Savannah River and carries considerable red sediment. Enough of this came through the walls of the tanks to stain the concrete in several places. This sediment might have been instrumental in stopping the leaks.

Lightning protection is provided by 10 rods of ¾-in. solid copper, set 2 ft. in the concrete and extending 5 ft. above the parapet; each of these rods terminates at the upper end in a three-point aigrette. The lower ends are wired to the reinforcing and in addition are sweated to a stranded copper cable. This cable forms a complete circle just above the concrete and is in turn connected to a similar cable embedded in the concrete just at the base of the lower tank. This bottom cable is connected to the expansion joint of the 12-in. riser pipe which acts as a ground.

The tanks are supplied by electrically - driven pumps and these are controlled automatically. In addition, metal indicators are provided on the outside to show correctly the amount of water in the tanks.

The concrete work was done by the Piedmont Construction Co., of Atlanta, Ga. The average force employed was 16 men, including the foreman, carpenter and helper. The metal forms which were used are of patented design. Only one form or course was poured each day, the balance of the time being spent in removing the forms set the day before and putting them in place for the next pouring.

The entire work was carried out under the Chief Engineer of the railway company, Mr. C. K. Lawrence, under the personal supervision of Mr. H. F. Sharpley, Jr., office engineer of the railway company.


El. 198.75
¾" Copper Rods
Stranded Copper Cable sweated to ¾" Copper Rods
Copper Cable sweated to Circumferential Cables
25'1"
36'6"
24'9"
28'
Stranded Copper Cable sweated to Vertical Cables and wired to Vertical Reinforcing Rods of the Structure
Iron Ladder
Copper Cable (6) 4" from face of Concrete
Seven-Stranded Copper Cable in Multiple Connecting Bored in Casting of 12" Riser Pipe Forming Expansion Joint for this purpose.
6"I.s supporting Walk 4' wide
12" Std Flanged Pipe
8" Spiral Riveted Pipe
6" Std Flanged Pipe
Ground Line
El. 110
Eng. News.
33'7"
10'
Elevation.
Enlarged Details.

LARGE REINFORCED-CONCRETE WATER TANK, SAVANNAH, GA.

*Assistant Engineer, Central of Georgia Ry., Savannah, Ga.

The Number and Cost of Cross-Ties purchased by the railways of the United States during the four years ending with 1910 is the subject of a preliminary statement just issued by the U. S. Bureau of the Census, Washington, D. C. The report was prepared by Mr. J. E. Welchel, expert special agent. The following is taken from the statement:

The steam and electric railroads of the United States purchased 148,231,000 cross-ties during the calendar year 1910, paying therefor, at point of purchase, $75,889,000, as compared with 123,751,000 in 1909, 112,467,000 in 1908, and 153,703,000 in 1907, costing $60,321,000, $56,282,000 and $78,959,000, respectively. The number purchased in 1910 was an increase of 20% over 1909, and 32% over 1908. Of the total purchases of cross-ties during 1910, 139,596,000, or 94.2%, were made by steam railroads, while electric railroads purchased 8,635,000, or 5.8%. The steady increase in the number of cross-ties reported as purchased for new track is noteworthy. The total based for this purpose in 1910 was 22,255,000, as against 16,437,000 in 1909, 7,431,000 in 1908, and 23,557,000 in 1907, the total for 1910 exceeding that for 1907 by 35.4% for 1908 by 199.5% and nearly equal that for 1907, the largest ever recorded. Largely as a logical result of the greater demand for cross-ties during 1910, the average cost per tie at point of purchase advanced to 51 cts., the same figure reached in 1907, as compared with 49 cts. in 1909, and 50 cts. in 1908.

In 1910, as in preceding years, oak was the principal kind of wood used for cross-ties. The number of oak cross-ties formed 46.1% of the total for 1910, as compared with 46.2% in 1909, 42.8% in 1908, and 40.2% in 1907.

A substantial increase in 1910 over 1909 is shown in the number of Southern pine cross-ties reported; the increase in the cut from this species over 1909 being 22.8%, as against an increase of 20% in the total number of cross-ties reported from all woods. Douglas fir also showed for 1910 over the preceding year a larger increase, namely, 28.2%, than the increase in the total purchase from all woods. On the other hand, chestnut, cedar and cypress, with increases over 1909 of 17.1%, 7.8% and 17.6%, respectively, were bought in relatively smaller quantities. While the bulk of the cross-ties were cut from the six woods mentioned during each of the four years and while combined they contributed 85.5% of the total in 1910, 85.3% in 1909, 86.5% in 1908, and 87.2% in 1907, a remarkable and significant showing in connection with the figures for 1910 is noted with reference to certain woods which hitherto have been utilized as cross-tie material to only a very limited extent. The increase in the number of cross-ties over 1909 reported as cut from elm, was 451.7%; gum, 328.8%; birch, 323.3%; spruce, 121.5%, and mesquite, 114.9%. A very large percentage of the cross-ties cut from these woods were given some preservative treatment, thus increasing their life to or beyond that of untreated cross-ties made from the more commonly used or standard cross-tie woods.

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Strenuous Railroading; Four Dead.

Two freight trains collided and killed four men; the crew of one train had been on duty nearly nineteen hours, and failed to obey one portion of a complicated train-order issued to them nine hours before. The case is an interesting reminder of practices that prevailed in some sections of the country before Congress passed the Hours of Service law, practices which caused many accidents.

A freight-train crew on the Soo line went on duty at 11 a. m., July 4, at Stevens Point, Wis., and took a long train of empties north, arriving at Ladysmith, Wis., 103 miles, at 9 p. m. the same day, having been ten hours on duty. Their day's work was not over, for they found a dispatcher's train-order at Ladysmith which took them 107 miles farther, to Superior, Wis., with the same train. On the stretch between Ladysmith and Superior there is no telegraph office. This train-order, moreover, was peculiar in prescribing meetings with five trains, one to be passed two or three hours after receipt of the order and the other six hours later. It read:

Eng. 2649 will run extra from Ladysmith to South Superior protecting against work extra 111 between Gordon and Solon Springs after 5 a. m., protecting against work extra 2415 between Solon Springs and Hillcrest after 5 a. m. and protecting against work extras 2414 and 2421 between Hillcrest and South Superior after 5 a. m. and will meet extra 2654 south at Stone Lake.

The train passed safely three of the trains designated in the order. On reaching the yard south of Superior the crew set out its train, which ended its 18½ hours' work. But at the yard there was no place to eat or sleep, so that the crew decided to run the engine and caboose into Superior, 6 miles. Two of the trains mentioned in the order issued the previous evening were still to be met. They had double-headed, with caboose in front and 29 cars of gravel behind. The engine hurrying toward Superior failed to protect against them, and collided with the combined trains at Nemadji River bridge: four trainmen were killed and two injured. The collision occurred at 5.50 a. m., when the crew responsible had been on duty nearly 19 hours.

The above is a plain statement of facts drawn from the report made by the inspectors of the Interstate Commerce Commission. Comment is unnecessary. An Act of Congress limits the hours of service of any railway employee to 16, to be followed by at least 10 hours of rest, and the inspectors recommend prosecution of the railway company for violating this law. Bad practices of long standing are not easily wiped out by mere legislation. Prosecution would help in securing observance of the Act.

Septic Tank Nuisances and Medical Health Officers.

Many septic tanks in the Middle West appear to have been the cause of at least as much nuisance as they were supposed to abate. This is due to improper design and operation, and also to the fact that many municipalities, institutions, companies and private individuals have put in septic tanks with a very exaggerated notion of what a septic tank might reasonably be expected to do, so such tanks have been called upon to accomplish the impossible.

The latest septic tank nuisance which has come to our attention is reported from Plankinton, S. D., where, it is stated, two physicians connected with the State Board of Health recently made an inspection to determine whether or not the tank was a menace to health. It appears that this particular tank has been the subject of litigation, that an injunction either forbidding its use or directing that it be operated differently has been granted by the court and that citizens of Plankinton claim that the injunction has been violated.

Perhaps the two medical men who went to Plankinton on behalf of the State Board of Health know more about septic tanks than the persons responsible for the design and operation of this particular one, but is it not rather anomalous to have engineering questions passed upon by a couple of doctors? A rapidly increasing number of our state boards of health are now employing engineers to assist them in their duties, and it is desirable that the practice should extend to every state in the country.

Some of our readers may remember that a few years ago the State Board of Health of Minnesota issued a blanket order requiring every municipality in the state having a sewerage system to install a septic tank. The board subsequently learned that a little knowledge is dangerous, and besides rescinding the order or abandoning attempts to enforce it the board has since added an engineer and an epidemiologist to its staff to help it decide what's what in public-health work.

If South Dakota is not yet in position to have an engineer of its own to look after purely engineering matters, we dare say that Minnesota would be neighborly enough to loan it an engineer for special investigations like the Plankinton case.

Both the Plankinton and the earlier Minnesota incident illustrate the perverted notion held by most laymen and physicians, and too many engineers, as to the relation between septic tanks and public health. We would not go quite so far as to say that it is measured by the number of snakes in Ireland, but from certain viewpoints that would not be far amiss.

Greater Berlin and Greater Birmingham.

The passion for creating Greater cities continues. Not so very long ago Pittsburgh was much enlarged in population and area by the annexation of Allegheny City, and quite recently the passion has manifested itself in both Germany and England. In May of this year it was reported that the Prussian Diet passed a Greater Berlin bill which by annexation brought the population of that city up to an estimated 3½ millions, beneath only London and New York. In the very next month royal assent was given to a bill which increased the area of Birmingham, England, from 13,477 to 43,537 acres (68 sq. mi.), and raised the estimated population to 900,000, or second among British cities to London.

It seems pertinent to remark, as we have done before in these columns, that city greatness is much more than a mere matter of area, population or wealth. This has been more fully realized in Birmingham and Berlin than in most of the American cities which have striven to affix Greater to their names. Pittsburgh was discouragingly slow in getting beyond the stage of materialistic ambition, but events in that city during the past few years show that it also has aspirations for true greatness. These have manifested themselves, among other ways, by the united effort of many of the citizens and civic organizations in extensive studies for comprehensive municipal improvements, possibly involving radical changes in the city plan.

Although in some respects foreign to the thoughts just expressed, we add as of no little interest a quotation from "The Local Government Officer and Contractor" ((London), which shows some marked differences between British and American ways of treating some of the troublesome questions which arise when a large city swallows up a number of smaller communities:

> Two financial questions of special difficulty had to be overcome in carrying through the scheme. There was the difficulty of satisfying the added areas in the matter of rating, a difficulty which was met by the Corporation [Birmingham] conceding the principle of differential rating on terms as favorable as possible. The other difficulty was the ever-recurring one of financial compensation to the county councils concerned for the loss of area and rateable value. A proposal was made that the Bill should be postponed until a report has been made by the joint committee which is now considering this vexed question of financial adjustment, but ultimately agreements were arrived at.
>
> Necessarily an extension scheme of this kind materially affects the interests of a large number of officials and other employees. As many as possible will be taken over by the Corporation, but in a number of cases it will be obviously impossible to find suitable openings. For example, it is not congenial for those who have themselves been heads of departments to accept subordinate posts, even under a great municipality and with remuneration as good as before. For these there will be compensation on the usual Civil Service lines, but unless the period of service has been long the amount received is really only something to tide over an interval until another satisfactory post is obtained. This extension scheme, however, was practically inevitable.

In the matter of "rating" (local taxation), the general practice in American city consolidations, so far as it has come to our attention, is to make little or no attempt to adjust the differences in assessment and rates of taxation.

Looking after the interests of the numerous groups of city officials affected by these consolidations is quite a different matter; but with us these generally must take the chances of partisan politics rather than be settled as nearly as is humanly possible by rules of justice.

A Shining Example of an Engineer's Integrity

Engineers are justly proud of the reputation which their profession, as a whole, has for honor and honesty under conditions which offer every opportunity for dishonest and illegal gain. Yet many engineers of unimpeachable integrity themselves are sometimes obliged to work with and for those whose motives and acts are far from disinterested. So long as an engineer is able to keep his own reputation unsullied, and is unable to prevent the crookedness of his superiors, he often justifies his own course by a feeling that it is no concern of his; that his work lies in the construction not in the financial end of the business.

But when those superiors come and ask their engineer to pad his estimates, to add cuts and fills to a railroad profile where none exist, that they may have an excuse for changing the esti-

mated cost from $30,000 to $50,000 a mile, we hope that the great majority of engineers would not hesitate to do what Peter A. Dey did when he resigned his office as Chief Engineer of the Union Pacific Ry.

Elsewhere in this issue we have endeavored to state briefly the main incidents in the life of this man, a man who of late years has been little thought of as an engineer, because he ceased to follow engineering years before most engineers of to-day began to practice. Much that is stated therein is recorded in history, some will say ancient history, and may be found in the reports of the Congressional committee which investigated the Union Pacific scandal in 1873.

We have related at some length the great crisis of his life and the manner in which he met it, not with any intention of reopening to disagreeable and almost forgotten pages the past history of the Union Pacific Ry., but to place before engineers, particularly young engineers and engineering students, a noble example of the honesty of a great engineer. And it is well worthy of record that the man who sacrificed the best engineering position in the country, and perhaps the chief ambition of his life—giving up being the builder of that first transcontinental railway—did not pass through life unrewarded, but was honored with public offices and esteemed, with a sincerity that only an upright and honest man can inspire, for nearly half a century.

A Rate Collector as Town Engineer and Man-of-all-Work.

Ever since Dr. Albert Shaw published his valuable book entitled "Municipal Government in Great Britain," we have read with particular interest numerous reports which have reached us from England showing that not everybody in that country has the same roseate view of British municipal government as did Dr. Shaw when he wrote his book. The latest instance of this sort which has come to our attention appears in the "Surveyor" for Aug. 4, 1911. Our contemporary states that the Urban District Council of Llangollen has "unanimously appointed their rate collector to the offices of surveyor, sanitary inspector, water inspector, rate collector and officer under the Town Planning Act," and that the "combined salary for these various and diverse offices is the munificent sum of £100 a year." The Council, however, graciously permits its man-of-all-work to render service elsewhere, provided it will not clash with his municipal duties.

The "Surveyor" calls particular attention to the fact that the appointee is "not proficient in sanitary matters," but adds that "he has undertaken to qualify himself within six months." Our contemporary then proceeds to enter well-deserved protest "against a system which renders such a state of affairs as exists at Llangollen possible."

The apparent remedy which our contemporary has in mind is an enlargement of urban districts to such a size as would enable "councils to appoint whole-time officers" with "adequate remuneration" for their services.

While we may not have exactly parallel cases in this country, yet there are plenty of instances where men entirely unfit for their duties are appointed to technical positions. This is partly due to political reasons, and in some cases to the real or imagined inability of the local authorities to pay money enough to secure the services of a competent man.

The remedy suggested by the "Surveyor" might often be applied in this country with good effect, although it would not always be necessary or wise here, as perhaps it is not in Great Britain, to effect an actual consolidation of small towns or districts. Instead, some form of cooperation might make it possible for an engineer to divide his whole time between a number of places. Of course, it is not at all uncommon for one engineer to serve a number of different municipalities, but generally this is done on a per diem basis, and without any cooperation whatever on the part of the several municipalities.

The First Gas and Electricity-Rate Case of the Public Service Commission for the First District of New York.

The Public Service Commission for the First District of New York has decided its first straight-out gas and electric rate case (Queens Borough Gas & Electric Co.). The report reviewing the case has aroused great interest, since it defines the position of this Commission on many questions relating to the valuation, depreciation and rates of public-service corporations. In another part of this issue, we have outlined the important features of the investigation in so far as they show the position and views of the Commission. The actual figures involved necessarily have been quoted to trace the argument, but the figures themselves are comparatively insignificant, certainly of less general interest than the review of the case. What the Commission has attempted to do is, of course, to find what maximum rates for service to the public generally will just permit a "reasonable return" on a "fair value." At the outset, the latter term is restricted to mean a fair value of property actually and necessarily in service. The Commission then proceeds in orderly fashion to determine and combine these two prime factors. The printed documents at hand disclose, above all, an attempt to do justice to the company and the consumers alike. The deductions of the Commission seem logical; their premises seem tenable throughout; the continuity of argument seems unbroken, with one possible exception to be noted later.

The records of the constituent companies preceding the Queens Borough Gas & Electric Co. failed to throw light on the fair value of the property and there was no consistent data on the unimpaired investment, so an engineering valuation was made. It is interesting to note what the Commisison has admitted as of capitalizable value, exclusive of physical property, as commonly understood. First, there is an allowance of some 20% on labor, materials and sub-contractor's profit to cover engineering, supervision, contingencies and general contractor's profit. This is to be compared with the 10% which might prevail for construction *en bloc* and the 25% asked for by the company. Land in use has been admitted at present value, following the ruling of the U. S. Supreme Court in the Consolidated Gas case. Land reserved for future use has not been admitted, and in valuing land in service a safe middle course has been sought between the boom figures of the real-estate agent and the notoriously depressed tax valuations, based on forced-sale ideas. The influence of improvement and most advantageous use has been admitted in fixing present land values. Development and promotion expenses have been allowed as a part of fair value of property, this item being very largely (70%) taxes and interest during construction. An average time of construction was estimated, but weighted in accordance with the cost of the various construction units in which the plant was built. The result, however, was simpler than the basic idea—an allowance of 6% was made on half the production cost, plus land value and development expenses. Working capital was allowed and based on the needs of the company, in the purchase and storage of supplies, for the payment of labor and fixed charges, and bearing in mind the delayed influx of receipts over deliveries. The Commission could find no logical basis for the working-capital allowance in assets or liabilities or financial arrangements other than noted.

One of the most interesting parts of the report is that dealing with the Commission's rejection of a separate allowance for "going value" of a "working concern." It has clearly distinguished between condemnation proceedings, where such an allowance may be permissible, and rate cases, where, in the Commission's views, there is no justice in a separate allowance. Adjustment and unification of a concern's affairs and plant are held to be covered in the allowances for preliminary or development expenses. Established clientele and good will are not to have the value for a monopoly that they might have under competition. The accumulation of data and experience are considered personal factors—attributes of the employees and presumably covered by salaries and wages. Moreover, adjustment and unification, good will, acquisition of experience and data, and experimentation, all of which affect going value are held to be recurrent or continuous processes to be covered by operating expenses alone, since it is practically impossible to define the proportion of the various annual expenditures which should be allotted to going value and which to operation, as the term is commonly understood.

Another important point is the refusal to capitalize early deficiencies in dividends and allowances for depreciation. It is not clear that the Commission would always adhere to such a refusal strictly, as in the case where definite values of such early deficiencies could be arrived at. Too small a return in early years is preferably to be compensated by higher rates in later years, that there may be no paying of dividends out of capital. The question of actual deficiencies in revenue, to meet fixed, operating, and depreciation charges, was not faced in this case, and the views of the Commission are not registered. There is ground perhaps to suppose that, where they can be definitely shown both as to existence and amount, the Commission might allow them to be capitalized, if they were not too many years old. Seventeen years furnish ample opportunity to make good the early deficiencies in return and depreciation reserves, the Commission holds, without burdening present rates. If the deficiencies have not been made good in that length of time, there is evidently prima facie evidence of poor management, in the absence, we suppose, of proof of unusual hardship from the public or from disaster.

It is interesting in looking back over the case to find how much water the Commission has squeezed out of the concern in question. The total capitalization at the date of the study was $4,403,760; the fair value for fair return allowed was $1,660,000, a difference of $2,743,760, or 62.3%.

The fair return itself is defined as one which would induce investors to establish or extend a similar plant in the area in question. In this area, it means 5 or 6% on bonds and 8 or 10% on stock, the ratio of bonds to stock varying between permissible limits of 50 and 66% for conservative financing. The actual figure used in this case was 8% on the whole fair-value allowance, representing 6% on bonds and 10% on capital and a ratio of 50%. The product of fair value and fair return, of course, should give the actual net return from operation, to which would be added the bare running expenses, taxes, and annual depreciation reserves to give the figure known as gross earnings which should prevail. If there were no other income than that affected by the rates complained of, the final step would be to divide these gross earnings by the total amount of commodity or service sold. However, complications arise in this case and are apt to arise in most other cases of similar nature. By state legislation, the City of New York gets preferential rates of 75 cts. per 1,000 cu. ft. of gas, and 10 cts. per KW.-hr. of electric energy. Then there are outside sources of income, like jobbing sales, office rent and sales of gas and power in large blocks. All such income, including that from municipal service, private street lighting, commercial power, etc., in this case have been subtracted from the computed "reasonable" gross earnings. The corresponding amounts of commodity or service have been subtracted from gross sales. The remaining earnings are divided by the remaining sales to find the unit reasonable rate for the more general service in question.

It is at this point, if at all, that the argument or conclusions are open to criticism—though it is true that the criticism may be explained away by the brevity of the records, which do not show a completeness of inquiry which may have been made. Is there assurance that the rates which have been made for private street lighting, commercial power, jobbing, etc., have not been in themselves unfair? If they have been too low,

then the "reasonable" general rates may be too high. If the private rates have been too high, then this secondary business is carrying in part the burden of the more general supply. In this particular case, any modification of the charges for the secondary service would possibly have no appreciable effect on the reasonble rates finally fixed. On that account, the neglect of the Commission at this point may have been more apparent than real. For other concerns and districts, this question of the influence of secondary business on the more general rates may have a greater bearing, and it is to be hoped that the failure of the Commission to record its views here will not give precedent for failure to study what we may call the private rates in any general investigation of rates for public service.

The question may well be asked, how may the reasonableness of rates for these secondary and large blocks of service or commodity in off-peak hours be determined? The company is to be permitted, even induced, to cultivate such business, of course, and perhaps to make on it a profit which would be unreasonable for the general public supply. There is ground for holding that the fixed charges, including taxes, are incurred solely for the public business or the peak-load supply and that the secondary business depending on the aggressiveness of management should carry little if any of the overhead charge. However, this secondary business should not be secured at a figure insufficient to pay the actual operating expenses, as usually meant by that term, and its pro rata share of depreciation, since depreciation may logically be apportioned on total output of plant. The cultivation of secondary business is usually most commendable, since it promotes efficiency in the production of supply for the general public, or for peak-load periods, through the elimination of standpipe wastes, economies in the larger purchases of material, etc. Its return, however, should justify its rates.

One of the interesting side lights on the proceedings in this case is in the compensated character of certain errors which may be made. For instance, if piecemeal construction is considered, the decreased overhead charges for engineering, supervision, contingencies and general contractor's profit are offset by increase in the actual cost of materials, due to buying in smaller amounts, than would be possible if the plant were being reproduced in a single contract. As another instance, if the annual depreciation charges against operation are too low, then the accumulated depreciation subtracted from reproduction cost in ascertaining present value is apt to be too small and the resultant fair value is apt to be high. What the consumer fails to pay, in the resultant rates, to meet depreciation, he pays as a return on a higher allowance for fair value. Again, as land is included in fair value at present worth, this influence is compensated for by including annual increase of value in receipts, offsetting depreciation.

Finally, one of the most significant principles laid down by the Commission is that if a company is entitled to earn dividends on land that has increased in value since its purchase then annual appreciation is to be added to revenue, just as depreciation is added to expense. Obviously this principal would be equally applicable to increase in franchise values, where they are given weight, but franchise values were not taken into consideration in this case.

LETTERS TO THE EDITOR.

Retaining-Wall Pressure Under Concentrated Loads.

Sir: In the issue of Engineering News for July, 20, 1911, p. 92, there appears a method for analyzing retaining walls with loaded filling. The author of that article derives the pressure upon the plane A C (in Fig. 1 herewith) due to the filling only, and then combines this with the superimposed load, getting the resultant total pressure R_{ac} on the plane AC. Thus far the analysis is entirely rational, but in the next step, wherein he gets the unit-pressure at the point A, he has derived it on the basis that the resultant R_{ac} intersected the plane A C at one-third the distance A C from A, and further that the pressure on plane A C was uniformly varying. This latter assumption is not correct, for the load may be only of the width D E as shown in Fig. 1, and therefore could not exert a pressure over the entire plane A C unless the mass were a true liquid. Instead the load will be spread through the filling as it goes down.

The amount of this spread could not be on lines at a less angle with the horizontal than the angle of repose of the material. From experience this line of spread is at a much steeper angle than the angle of repose, but this feature will be considered later. Thus it is seen that the unit-pressure along the plane A C from the point C to the intersection G of the line of spread of the superimposed load with the plane A C, is the same as if there were no superimposed load on the fill. From this point G downward the unit-pressure is of some greater value than under the condition of no superimposed load. The exact amount of this pressure depends entirely upon the spread of the superimposed load in the fill and upon its location and width with respect to the wall.

Furthermore, after the author had presumably derived the pressure at the point A on the plane A C and then derived the conjugate pressure on the face of the wall, he assumed the pressure on

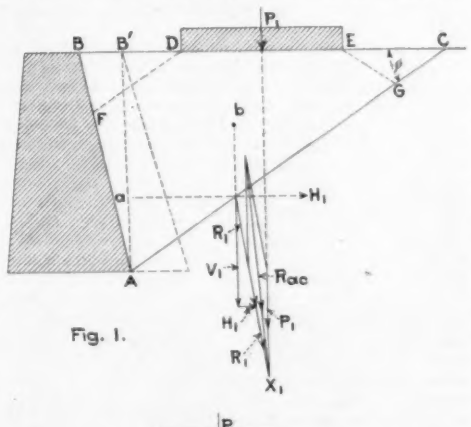


Fig. 1.

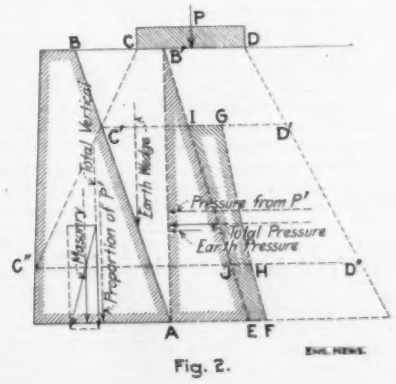


Fig. 2.

the wall to be uniformly varying from that value to zero at the top. It is seen again that this is affected by the spread of the superimposed load through the fill. It is evident that above the spread-line the load can exert no influence on the wall. The diagram representing the actual effect on the wall must be other than a triangle. The problem then is to discover the shape of this diagram representing the effect of the superimposed load below the spread-line.

The whole problem hinges on ascertaining the spread of the load through the fill. To the writer's knowledge no investigations have been made which will settle this question beyond dispute, mainly due to variation in the composition of the filling material. But from observation of failures of culverts and similar structures under earth fill the spread has been found to vary from a spread of 6 ins. lateral per foot of height, to 12 ins. per foot, in ordinary filling material. These two degrees of spread would give different loads on the wall, but as the second value would give greater overturning force (because it would intersect the wall surface nearer the surface of the fill) it should be used in preference to the first. Even this is much less spread than that between the slopes of the angle of repose, but to assume so great a spread as the latter is unwarranted by past experience.

For determining the pressure on the wall, I will first assume that the superimposed load is continuous along the wall at a fixed distance from the wall. First the force acting on the wall due to the earth fill alone is found. Instead of following the usual method of finding the total pressure on the wall, which is at some angle with the horizontal, depending upon the slope of the wall, I will figure the horizontal pressure on a vertical plane AB', Fig. 2, and this, combined with the weight of the earth wedge ABB', would give the total force on the back of the wall AB. It is, however, unnecessary to combine these, as the total horizontal pressure may be combined with the total vertical pressure to get the resultant pressure on the base of the wall direct. Another advantage of this method is that the ratio of the horizontal to the vertical resultant represents the tendency of the wall to slide on its base and this ratio is had directly without figuring the two components as would be necessary if the usual method were followed. The value of the horizontal pressure on the vertical plane AB' due to the earth only is represented by the triangle AB'E, Fig. 2.

Next the superimposed load is assumed as spread over the distance CD, giving a vertical unit-pressure p at the surface. Due to the spread of the load through the fill this unit-pressure will decrease from the surface down. At the point C', where the spread-lines first intersect the back of the wall, the load has spread over a width C' D' and the vertical unit-pressure is P'/C'D' = p'. Below the line C'D' the load will spread toward the back through the fill and toward the front through the wall. The slope of the spread through the wall is assumed to be the same as that through the fill and this spread-line will intersect the front face at the point C", at which depth the vertical unit-pressure will be P'/C"D" = p". Between these two depths the change in unit-pressure is constant, but below C" D" the change will be less as the load can no longer spread toward the front. Knowing now the vertical pressure at any depth the horizontal pressure can be found as in the case of the earth fill. This is done by applying Rankine's formula. For the horizontal pressure at the plane C' D' we have the value represented by I G in Fig. 2. Above this point there will be no horizontal pressure on the wall. At the depth of the plane C" D" the horizontal pressure will be represented by J H and at the bottom by E F. To get the total pressure exerted it is now only necessary to sum up these unit-pressures and finding the center of gravity of the system we can get the effect on the wall due to the superimposed load. This, combined with the earth pressure, will give the total pressure acting on the wall. Having now obtained the total horizontal pressure and its point of application it can be combined with the total vertical pressure to get the resultant on the base of the wall. In getting this total vertical load it is necessary to consider the weight of the masonry, the earth wedge A B B' and the portion of the superimposed load spread over the base.

It is seen from this analysis that the closer the superimposed load is to the wall the greater will be its overturning effect upon the wall, as is to be expected, which is not true in the article referred to at the beginning of this letter.

The above analysis holds for the case of a wall with say a railroad track or continuous building foundation adjacent to it, but requires a slight modification if the superimposed load is in the form of a column. Furthermore, if we have the case of a double-track railroad between parallel walls the load can not spread back farther than the center line between tracks, increasing the overturning effect slightly. The method of allowing for this is of course evident from the analysis above. In the case of the filling loaded with a column footing it is evident that the load can spread in four directions, reducing the vertical unit-pressure a correspondingly greater amount than in the previous analysis. The effective horizontal unit-pressure is constant from the bottom up and is equal to the value at the bottom because the greater unit-pressure at the higher level is not continuous for the full length of the wall and before the wall fails it will have to spread the load at least as far as the spread at the base. Of course, due account should be taken of joints in the wall which would hinder the load from spreading across the joint. Furthermore the overlapping of spread lines from adjacent column footings should be allowed for.

Another adaptation of this method is to the analysis of the retaining wall type of abutments for bridges. In this case the load is only of limited extent in the direction of the wall and is practically continuous at right angles to it, therefore giving spread in two directions only. The an-

alysis of this ought to be clear after the explanations given above.

Although all features of the above analysis are not above criticism and may not require as large wall sections to preserve stability as some other analyses that might be developed, nevertheless, in view of the satisfactory performance of many walls built according to it in the last few years, it is considered a perfectly safe analysis. However, the writer would appreciate any comment or criticism of any part or the whole of the analysis which might be offered by any of your readers. Yours truly,

Donald N. Becker, C. E.

4409 Greenwood Ave., Chicago, Ill.

Sir: In your issue of July 20 the statement made by Mr. E. K. McDowell concerning the paucity of information regarding the lateral pressure against a retaining wall or similar surface caused by concentrated loads at a distance from the wall will receive the hearty concurrence of all engineers who have had occasion to consider the effect of such loads. The method of using an assumed equivalent uniform load above the top of the wall is far from satisfactory and any analysis which will come nearer to fitting the case will be sincerely welcomed.

The method suggested by Mr. McDowell is ingenious, but, without commenting on the theory in general, whether or not it is a step in the right direction, I would point out one consideration which indicates that at least it is not a complete solution.

The diagram presented, Fig. 1 of the article, shows the load as located in a particular position resulting in a given resultant R_{ac} applied at a particular point on the plane AC. Using the magnitude and direction of this resultant, an expression is derived for the unit-pressure at the lowest point of the plane AC, that is, pressure $= 2R_{ac} \div AC$. The value given by this formula is independent of the point of application of the resultant and depends only upon its magnitude and direction and upon the length of the plane AC.

If, now we consider the effect of an equal load located either nearer the wall or farther away from it, the resultant R_{ac} is not changed in either magnitude or direction but its point of application by Mr. McDowell's method gives the unit-pressure at the foot of plane AC the same for all these cases, and therefore also the resulting values of AZ and R_s as derived by his method. This, the writer believes, is clearly contrary to the facts for it will hardly be disputed that a load near the wall will have a very different effect in the way of lateral pressure on the wall from that of an equal load far from the wall, both in its total magnitude and in the manner of its distribution over the surface. To account for this difference the distance of the load from the wall should in some manner be introduced into the discussion.

The writer has had occasion to give careful consideration to this matter of the effect of concentrated loads in lateral pressure against adjacent surfaces, and has himself evolved a tentative method of determining this effect, which is, however, not entirely satisfactory, and he will be glad to see some rational solution of the problem which will be applicable to ordinary conditions and be in harmony, so far as possible, with known facts.

W. L. Cowles.

902 Fort Dearborn Building, Chicago.

The Good Roads Craze.

Sir: I note in your issue of Aug. 10 a letter from "A. C." in which he criticises the Good Roads movement, as being a waste of public funds. I fully agree with him in that respect, and consider it nothing less than an outrage to spend the amount of money necessary to pave a road through the ordinary farming community, as it is settled at present. I know of routes for such paved roads that have been surveyed where the improvements won't average one set of farm buildings to the mile, and I have no doubt that there are worse cases than that.

I was instrumental this summer in securing signers to a petition for paving the street on which I live. I found the sentiment of the property owners (with two exceptions) to be in favor of the improvement, but they were loth to sign the petition because of the cost of it. Think of it! The lots run from 35 to 100 ft. front and the property owner was to pay one-third of the entire cost, which would not be more than $5 or $6 per lin. ft., or $2 or $3 per ft. of frontage. Yet these same people would think it entirely proper for the state to pay the entire cost of paving a country road where each property had a frontage of a couple of hundred times as much, and the number of persons benefited only a very small proportion of the public.

The sentiment of the average community favors too much the idea that anything secured from the state through political "influence" is like "getting money from home" and should be snapped up at once.

The Pennsylvania Legislature passed a bill this year calling for a system of improved roads throughout the state, usually between the different county seats, and appropriating $50,000,000 to meet the cost. It is generally conceded that a brick-paved road will be built in the majority of cases. To my mind this is a mistake. The bill is all right as far as it goes, but it should include every public road in the state, putting them all under the direct or indirect supervision of the State Highway Department, and all road taxes should be paid in cash to that department, and all repairs, etc., to the roads should be made under their supervision and direction. But *all* the roads should first be made as good as possible with the material at hand, or with the cheapest material available, by means of good drainage, and improved methods of road building drags, rollers, etc. When the entire system of roads throughout the state has been put in the best condition possible by such methods, it will then be time to still further improve the most important ones by paving.

The Sproul Highway Bill, above referred to, as it stands will benefit, first, the brick manufacturers who have "political influence"; second, the automobile tourist, who, by the way, represents only a small portion of the automobile owners; third, a very small portion of the country residents, farmers, who are fortunate enough to be situated on or near these state roads; and lastly, the majority of the automobile owners and others who, like myself, like to take a drive out of town in the evening, but who as a rule prefer to drive out a couple of miles or more and then, crossing to some other main road, return to town by another route. If the entire system of public roads were improved as I have suggested, all the farmers, and all city residents who keep a horse or automobile for pleasure, would be benefited greatly; the tourist would receive what benefit is due him, and the only ones to suffer would be the ones who would otherwise benefit by their "influence."

In conclusion, let me say that I own and drive an automobile, and I sincerely hope that a statewide system such as the Sproul Highway Bill calls for, will not be constructed of brick paving, or if so constructed, it will be along the lines followed in Illinois and Ohio, as shown in your issue of Aug. 10, 1911.

H. M. Kanarr.

Punxsutawney, Pa., Aug. 16, 1911.

Artificial Architecture in England.

Sir: I have noted with interest the particulars of the "artificial ruins" in your issue of Aug. 17, and the case in question reminds me of a somewhat similar case in England. The owner of a certain country estate deplored the fact that while the view from his house commanded a magnificent landscape, there was no "baronial hall" or other "noble pile" to lend distinction to the view. To supply this distressing need, he had a stone "castle" built on the summit of a hill, the structure consisting simply of a wall with battlements, windows and towers. It has a very imposing appearance (from the proper point of view), but a near approach soon shows that it is a sham. A discriminating neighborhood promptly dubbed it "Sham Castle," by which name it is known to this day. It is probably 60 to 70 years old.

An English Engineer.

The Comparative Designs of Reinforced-Concrete Floor Panels.

Sir: The paper by Mr. J. Norman Jensen on "The Economical Design of a Reinforced-Concrete Floor Panel" in Engineering News, Aug. 3, 1911, p. 133, is interesting and important. Unfortunately Mr. Jensen has not designed correctly the two-way hollow tile slab, called in the paper, "Design No. 6," and consequently his comparison of the economic values of the fourteen different types of construction is misleading as far as this type is concerned.

The bending moment for intermediate or continuous rectangular crosswise reinforced floor slabs of this type is $\frac{Wl}{36}$, in which W represents the total load of the entire panel and l the side of the square or the longer side of the rectangle. The bending moment for a similar slab with free supports is $\frac{Wl}{24}$, or $\frac{Wl}{24}$ per lin. ft.

Redesigning panel No. 6, assuming the same conditions as to span, loading, bending moment, etc., as used by Mr. Jensen, we get

$$M = \frac{Wl}{24} = \frac{86{,}100 \times 20 \times 12}{24} = 861{,}000 \text{ in.-lbs.}$$

$$a = \frac{M}{d \times 0.89 \times f_s} = \frac{861{,}000}{6.5 \times .89 \times 18{,}000} = 8.2 \text{ sq. ins.}$$

of steel.

As 28 rods are prescribed, 14 each way, which is ⅝-in. diam. round bars, 15 ins. on centers. Weight of steel per sq. ft. of floor $1.043 \times 12/15 \times 2 = 1.67$ lbs. plus 0.95 lbs. in two beams belonging to each panel totals 2.62 lbs. per sq. ft.

The unit price of steel used by Mr. Jensen is 3 cts. $2.62 \times 3 = 7.9$ cts. for steel, against 14.4 cts. given on Mr. Jensen's table. This reduces the total cost per sq. ft. of slab from 39.7 cts. to 33.2 cts.

The beam centering amounts to 99 sq. ft., whereas the table gives 130 sq. ft. In estimating centering it is customary to figure the entire floor area for flat centering and then add only the vertical parts of the beam forms. Mr. Jensen figured the entire panel of 400 sq. ft. for flat centers and then adds the beam forms, sides and soffits, thus doubling up on the soffit. Correcting this we get a further reduction of 0.8 cts. per sq. ft. and our cost per sq. ft. of slab comes to 32.4 cts. instead of 39.7 cts.

Using the right bending moment, $\frac{Wl}{36}$, we get a comparison of value and more just to this important but much abused type of construction. Under the same conditions, excepting d, which is to be 7 ins. instead of 6½ ins., following Mr. Jensen's rule that the distance of steel from the surface should equal the diameter of the rods, but be at least ½-in.

$$M = \frac{Wl}{36} = \frac{86{,}100 \times 20 \times 12}{36} = 574{,}000 \text{ in.-lbs.}$$

$$a = \frac{M}{d \times 0.89 \times f_s} = \frac{574{,}000}{7.0 \times .89 \times 18{,}000} = 5.14 \text{ sq. in.}$$

of steel.

$5.14 \div 28 = 0.18 =$ ½-in. diam. round rods 15 ins. on centers.

Weight of steel per sq. ft. $= 0.667 \times 12/15 \times 2 = 1.07$ lbs., plus 0.95 lbs. of steel in beams, totals 2.02 lbs. Using the unit price of 2¾ cts., which is used for design No. 14 and is justified in this case because it does not require any more bending and wiring, we get $2.02 \times 2.75 = 5.6$ cts. instead of 14.4 cts. This and the reduction of 0.8 ct. for beam forms bring the price per sq. ft. of slab from 39.7 cts. down to 30.1 cts.

It is not necessary to design this construction as a series of T-beams. It is a slab pure and simple. The shear values never run over the permissible values. The filler block is placed below the neutral axis. Even in cases where the tile reaches a fraction of an inch over the neutral axis the conditions of the slab are retained, because the tile is able to withstand the very low compression stresses which occur so near the neutral axis. This is especially true of the more compact tile, consisting of one piece and which is now used by the firm which formerly used the four-piece block mentioned in connection with Design No. 6.

The extraordinarily strong adhesion of concrete to clay tile justifies the assumption that at least the shell of the tile which is embedded in concrete on all four sides helps to resist shear and compression.

Unfortunately Mr. Jensen does not disclose how he managed to get so much steel into his crosswise slabs. He states himself that the conclusion, that a plate supported on the four corners is stronger than a plate supported along the four sides, is ridiculous on the face of it. From this it appears that he believes a plate supported along the four sides to be as strong or even stronger than the same plate supported on the corners only. But his own design of a plate supported on four sides required far more materials than a plate of the same capacity supported on the corners only, and even considerably more than a plate supported on two sides only. This is indeed a serious contradiction. If his design were correct, a given plate supported

on the four corners would be weakened by getting additional support along the sides or a similar plate supported on two sides would be weakened by getting additional support on the other two sides. This of course, is absurd reasoning, but it is actually what a design amounts to which requires more material for a plate supported on its four sides than for a plate supported on the corners or on two sides only.

In designing his crosswise slabs, Mr. Jensen apparently proceeded as follows:

For reasons which he does not disclose, he decided that $\frac{wl^2}{24}$ should be the bending moment. He then divided his unit load by two, believing that one-half the load would be taken care of by beam action one way and the other half the other way. Then, in order to make up for the cutting in half of the load, he doubled up on the bending moment and solved for $\frac{wl^2}{12}$. This procedure would result in his Design No. 6. It is a mistake commonly made by engineers unfamiliar with multiple way reinforced concrete. Only recently the writer had to check designs of crosswise reinforced plates which called for the same thickness of slab and exactly twice the amount of steel required for a one-way slab of the same span and capacity. Mr. Jensen states correctly that a square plate tested to destruction cracks along the diagonals. He fails, however, to draw a lesson from it.

Correct formulas for the design of rectangular slabs supported on four sides may be found for instance in C. von Bach's "Elastizitaet und Festigkeit." His formulas correspond to $\frac{Wl}{24}$ and $\frac{Wl}{36}$, respectively. They are derived mathematically, which ought to convince even a conservative engineer, but which is far more important, they have been found correct by a great number of tests. The writer himself has designed, erected and tested many slabs supported on four sides and always found von Bach's formulas absolutely reliable and safe.

The correct comparative price of 30.1 cts. per sq. ft. for the crosswise slab comes to within 0.2 ct. of the flat slab type, Design No. 14, the lowest in cost on Mr. Jensen's table. Hollow tile suitable for two-way reinforcement, and much cheaper than the 4-piece block, has been put on the market recently. This and the saving in columns and foundations, owing to the lesser dead weight of the crosswise reinforced hollow tile slab, may bring its cost below that of the flat slab. It is far superior in economy and efficiency to any one-way type. The slab under discussion for instance would safely sustain a concentrated load of 15 tons. Less than one-half of that load would go clean through any of the one-way slabs. The square slab is unequalled in economy in buildings like schools and hospitals, where the beams can be placed in the partitions, and in wall bearing or narrow buildings where continuity of construction cannot be obtained. In wide buildings, such as factories, warehouses, etc., the flat slab or mushroom type will hold the field.

K. R. Schuster, Assoc. M. Can. Soc. C. E.

113 Bainbridge St., Brooklyn, N. Y., Aug. 11, 1911.

Sir: We have carefully studied the article on "The Economical Design of a Reinforced-Concrete Floor Panel," by Mr. J. Norman Jensen, appearing in your issue of August 3, p. 133, and are very interested to note the conclusions arrived at by him.

We regret to find, however, that the data published in the article are not sufficient for the reader to check up the computations made and, inasmuch as the conclusions reached differ somewhat from our own experience, we should like very much to have the opportunity of comparing Mr. Jensen's calculations with our own in order to gain the greatest possible benefit from the article.

Mr. Jensen does not show in his illustrations the amount of reinforcement used in any of his designs and the summary of quantities does not state how much of the steel is in base sizes and how much is smaller. The summaries also do not state clearly the unit prices of the various items and the author does not state whether steel is placed by steel erectors or laborers and whether the tile is placed by masons or laborers. We think that if Mr. Jensen would supplement his article with information on these points the article would be more interesting and the data given of more value to engineers and contractors.

Two important points on which we would criticize Mr. Jensen's article are these:

In comparing cost of flat slab floors having "Mushroom" column head with other designs, the cost of the form and concrete to the head ought to be added to the cost of the floor. We have found these head forms quite disproportionately expensive.

As a tile floor is usually plastered on the under side and a plain reinforced-concrete floor is never plastered on the under side in manufacturing buildings (to which Mr. Jensen's designs would chiefly apply) the cost, therefore, of plastering should be added to the tile floor costs and the dead load of plastering should be omitted from the plain reinforced-concrete floor designs.

Lester H. Allen,

Aberthaw Construction Co.

8 Beacon St., Boston, Aug. 16, 1911.

Sir: In the far west where the high freight charges upon structural steel give an added importance to the subject of reinforced concrete, engineers are deeply interested in any development of the science or art of this mode of construction. Mr. Jensen's article in your issue of Aug. 3, 1911, p. 133, is timely and interesting. It shows considerable thought and some ingenuity. His "cut and try" method of determining relative economy is undoubtedly the only feasible method.

The results admittedly neglect, however, some pertinent elements of the structure. Let us consider, for example, the effect of dead floor weight upon the cost of columns. It is perhaps fair to regard the column cost as 40% of the total cost of rough structure, the floors 40% and walls 20%. Assume that one-third of the column load is from walls, and two-thirds from floors. Assume that one-fourth of the floor load is live and three-fourths dead. Assume that the cost of column is proportionate to its load. Then one-half of the column cost, or 20% of the total cost of rough structure, is proportionate to the dead floor load, whereas 40% of the total is proportionate to the cost of the floors.

Upon these assumptions it is found that Design No. 1 is cheaper than any of the others except No. 9, which is 2.3% cheaper than No. 1. Design No. 14 is 2.1% more expensive than No. 1.

If it be assumed that the story heights are reduced by the amount saved in depth of girders, Design No. 14 again takes rank as the cheapest construction. This, however, is a fair assumption for only a limited class of buildings. Ordinarily the clear ceiling height is the desideratum, and a reasonable projection of beams is not objectionable, especially if they follow the partition lines, as in some of the designs.

The slanting ceilings shown in several of the designs would probably be objectionable to architects—and the tile which is reckoned to cheapen certain designs would act differently in regions remote from the tile industry.

The foregoing is offered not for the purpose of detracting from the value of Mr. Jensen's article. His method of working is the right one and the results presumably correct within the limitations set. But the necessity of independent investigation for each case arising is here emphasized.

One statement in the paper is worthy of special note: "There are almost as many opinions as to the design of a flat plate as there are engineers." This fact will probably have to be admitted. It is a fact due to the lack of conclusive experimental data, and a problem that demands solution at an early date if we are not to go on blindly guessing as to the factor of safety in this type of construction.

I desire to digress far enough to call attention also to the lack of agreement, for the same reason, regarding the best methods of splicing vertical rods in columns, and the uncertainty that exists concerning the strength of such joints as now usually made.

John L. Hall.

Seattle, Wash., Aug. 8, 1911.

[We have submitted these letters to Mr. Jensen and have received from him the following reply.]

Sir: The writer will reply to the items in Mr. Schuster's letter in about the same order in which they are given.

At the outset the writer wishes it clearly understood that he is not interested in the sale of any patented floor tile or any reinforcing bar. His prime object in preparing the fourteen designs was to obtain a fair comparison of different designs based on the same general conditions. On the one hand it was not his intention to exploit any particular system of construction. On the other hand he realized that he would probably tread on somebody's toes in presenting these designs.

In order to compare two designs it is necessary to come to a common understanding as to the loads, etc. The weight of the floor shown has been taken at 78 lbs. per sq. ft., cement finish at 13 lbs., plaster at 5 lbs., and live load at 100 lbs., making a total per sq. ft. of 196 lbs. Load carried by joist $= 196 \times 1.25 \times 20 = 4{,}900$ lbs.

$M = 1/24 \times 4{,}900 \times 20 \times 12 = 49{,}000$ in.-lbs.

$$A = \frac{49{,}000}{18{,}000 \times .86 \times 6.5} = .49 \text{ sq. ins.}$$

Two ½-in. square bars were placed in each rib.

Referring to Mr. Schuster's computations as given in the third paragraph of his letter, the writer wishes to point out an error. The moment which Mr. Schuster obtains is the total moment on a strip the whole width of the panel, and the steel he obtains is the total steel required in one direction only. The same steel must be placed at right angles. The steel required in each joist is therefore $8.2/14 = .59$ sq. ins. This is about 20% greater than that required in the writer's design. Mr. Schuster has divided by 28 instead of 14, and as a result has just half the steel required in the job.

His weight per sq. ft. is equally in error. In computing the weight of the slab steel he has entirely overlooked the fact that the writer has stated that one-half the bars were bent up and extended to the quarter point on both sides. Such errors, if continued, would bankrupt a contractor. He does not state how he obtains the weight of steel in the beams. The writer figured 1.43 lbs. per sq. ft. instead of 0.95 lbs. given. Perhaps Mr. Schuster has not included the weight of the stirrups or the top bars in his beam.

The writer does not object to having his design cut to pieces. He does, however, believe that he knows the unit prices in the middle west sufficiently well to give them correctly. When he says that a unit price of 2¾ cts. can be used in Design No. 14 he does not mean that that same price can be used in the design in question. When he says that slab forms are measured center to center of columns, and beam forms on the two sides and the soffit, he means just that as his unit prices are based on this method of measurement. The unit prices given are the minimum and are based on almost ideal conditions. The writer is perfectly aware that he has counted the soffit of the beam twice. He also knows that if he deducted the soffit a considerably higher price for beams would have been used.

Mr. Schuster has repeatedly stated that the correct bending moment is Wl/36, "derived mathematically, which ought to convince even a conservative engineer." The writer is indeed glad to be considered a conservative engineer. He does not wish to belittle mathematical ability, but he knows as well as all competent engineers know that to depend entirely on mathematical analysis is dangerous. The theory of continuity, for instance, is based on the assumption of absolutely fixed supports. Suppose there is a settlement of ½-in. in one of the supports. Has Mr. Schuster ever computed the new bending moment under these conditions? If he has he will fully realize that it is not wise to stick too closely to mathematical derivation of bending moments.

Mr. Schuster has quoted a foreign authority to sustain his position as to the bending moment. It is a fact that foreign engineers, notably the German and the French, can do things in reinforced concrete that we Americans dare not do. When the rigid governmental inspection and the careful design and supervision of the work of the Germans is compared to the haste and the carelessness of the Americans, it is indeed necessary to be more conservative in our designs.

In regard to shear in the rib of the joist the writer does not agree with Mr. Schuster in that the shear does not exceed permissible values. A value was obtained which was higher than allowed by the Ordinance, and for this reason part of the bars were bent up to aid in carrying diagonal tension. He refuses to believe that the ribs of the filler block can take either compression or shear, as these filler block perform no structural duty whatever. They are filler blocks, nothing else.

"Unfortunately Mr. Jensen does not disclose how he managed to get so much steel into his crosswise slab. For reasons which he does not disclose he decided that wl2/24 should be the bending moment." It seems to be a mystery to Mr. Schuster. The writer will try to explain. As stated in his article the design was based on the Revised Building Ordinance of the City of Chi-

cago. In order to make it perfectly clear the writer went to the trouble to repeat the Building Ordinances, verbatim. He can not understand how these clauses in the Ordinance could have been overlooked by Mr. Schuster. They are all there on p. 133 of the issue of Aug. 3, 1911.

Perhaps the writer may be allowed to digress at this point in regard to building ordinances. He has made a special study of the laws governing building construction in various cities. He has seen the wide variation in those sections relating to reinforced concrete. He has known the motives in several cities for adopting certain clauses which favored certain types of construction. He has seen that most building laws are copies of either the New York or Chicago Ordinance. Of these two cities the writer considers the Chicago Ordinance vastly superior in those sections relating to reinforced concrete. He believes the Chicago Ordinance represents the best practice of the day. It is neither too liberal, allowing a dangerous form of construction, nor is it too conservative, discouraging the use of reinforced concrete. He is personally acquainted with the men who labored for three years to make the Revised Chicago Building Ordinance the best set of building laws in the United States. He is of the opinion that these men knew exactly what they were doing when they framed that ordinance.

The writer knows that his design is in accordance with the letter and the spirit of the ordinance. He also knows that his design would be acceptable to the Building Department of the City of Chicago while both of Mr. Schuster's would not. The computations as to the design and the quantities have been carefully checked and he is reasonably certain that they are correct.

It may be that too high a unit price has been used for the two-way tile shown in the design, but this price was based on the current price of this block or other blocks equally as good. If Mr. Schuster will quote a bona fide price of a 6-in. two-way tile, 15 ins. square, in car load lots f. o. b. Chicago, the writer will gladly revise the unit cost of Mr. Schuster's tile.

In regard to Mr. Allen's question the writer regrets that the data presented in his article were not sufficient for a comparison to be made with the results obtained. Perhaps a few remarks may clear up some of the points in question.

Before the writer are 36 sheets standard letter size containing his calculations in the design and quantities of the 14 designs submitted. There are so many figures and designing sketches on some of the sheets that the writer hesitated to submit this great mass of computations to the editors. There is probably enough material in these 36 sheets to completely fill two issues of Engineering News. For this reason the writer decided to submit only the results of his computations without any detailed analysis as to how these results were obtained. In his article he submitted the Building Ordinances which guided him and the formulas which he used throughout, in the hope that the reader could check his design with the information given.

In order to show the steel reinforcement completely it would have been necessary to show a plan and section of the slab and an elevation and section of the beam of each design. It would have been impossible to give this information on the small sketch shown so that it was omitted, and an attempt made to describe the general arrangement of the steel. Perhaps the method of reinforcement which the writer had in mind was not clearly brought out by him.

The writer has a complete schedule in his notes of the sizes and lengths of all bars in each design, and also the weights of all straight and bent slab bars, beam bars, and stirrups. He can furnish this information if desired. In giving the unit price for steel he obtained an average pound price for all the steel in the panel including the bending and placing of same. He believes the rest of the quantities in the summary are sufficiently clear. The unit prices used are not given in the summary, but are given in the discussion of each design. The cost per square foot is obtained by multiplying the quantities by the unit price and dividing by 400, the total area of the panel.

In regard to unit prices the writer wishes to state that they are the prices which would be used in the larger cities in the middle west. They are not necessarily representative of Chicago prices as the labor situation at present writing is such that it is difficult to estimate unit costs. The labor unions have been engaged in a long drawn out jurisdictional strike, and it is not decided whether ordinary labor should be used in handling the steel and tile in reinforced-concrete work or whether steel erectors shall handle the steel, and masons the tile. The unit prices used were based on the use of ordinary labor at 37½ cts. per hour.

The writer agrees with Mr. Allen that the column cap in the "mushroom" flat slab is a large item of expense due to the fact that it usually has a molded head made in sheet metal forms. When the slab with its column and cap is compared with other designs with their column the apparent advantage of the last design over other designs may vanish. To be consistent, however, the writer did not consider the column and its cap.

The criticism in regard to plastering is very well taken. As stated in the beginning of the writer's article this item of plastering was only added to place all designs on the same basis.

J. Norman Jensen.

1518 N. Leavitt St., Chicago, Ill., Aug. 19, 1911.

Rates of the Queensborough Gas & Electric Co.; The First Commodity-Rate Case of the Public Service Commission for the First District of New York.

An opinion and order fixing the rates for gas and electric service to be charged by the Queensborough Gas & Electric Co. have recently been published by the Public Service Commission for the First District of New York. The actual interests involved in this case are comparatively insignificant, but the proceeding is of special interest because it is the first of the kind before this Commission, and shows the logical development of rates along lines approved by this Commission as dealing substantial justice to the consumers and to a public-utility concern. This company supplies customers in the Fifth Ward of the Borough of Queens, New York City, comprising a portion of the outlying districts of Long Island included in Greater New York.

It appears that complaint was made, apparently in accordance with the provisions of the Public Service Commission law, that the company was over-charging consumers, the rates to ordinary gas customers being $1.30 per 1,000 cu. ft. and 15 cts. per KW.-hr for the vast majority of consumers of electricity. The complaints undoubtedly arose because of the marked difference between the rates quoted and the corresponding ones in other sections of the boroughs of Queens and Brooklyn, the residents not fully understanding that the outlying character of the territory and the fluctuating population could have any effect in increasing cost of service. Of course, the company claimed that it had reduced its rates as rapidly as possible and that it would continue these reductions if its finances would warrant.

Formal proceedings were started and the Commission began to take evidence. After several weeks the company, feeling the burden of the large expense and inconvenience in completing its side of the case, requested the Commission to establish maximum rates for gas and electricity for the company, agreement being made to put them in force at any time after Jan. 1, 1911, and to continue them for a full, fair and complete trial. In view of this agreement of the company to accept the determination of the Commission in advance, it was decided to adjourn formal proceedings and to finish the study of the various factors involved by open and informal conferences with the representatives of the company and the complainants. The advantages of this procedure the Commission sums up as follows:

> When there is the possibility that the record may be reviewed by writ of certiorari, the procedure tends to become formal and technical. Every party concerned hesitates to be free and open, for fear that some slip or inadvertent admission may be used against him. Exceptions to rulings are generously made in order that every possible point may be reserved. The record often becomes verbose, cumbersome and discursive without clearly setting forth the fundamental facts.

DEVELOPMENT OF THE COMPANY.—The preliminary work was in tracing the history and corporate relationships of the Queensborough Gas & Electric Co., whose rates were complained of. Such a preliminary study was necessary to an understanding of the complications of early financing and accounting. Naturally this company was found to be the resultant of several corporations. In 1880 the Rockaway Gas Light Co. was incorporated, and in 1882 its rights and property passed to the Town of Hempstead Gas & Electric Light Co., which was merged with the Queensborough Gas & Electric Co. in question in 1902. The first electric company was the Rockaway Electric Light Co., incorporated in 1890, but later merged into the Queensborough Gas & Electric Co. in question. There was also the Citizens' Lighting Co., incorporated in 1892. Its property and rights were sold to the Queensborough Electric Light & Power Co. in 1898. This last concern also acquired certain rights from individuals. It was merged with the Queensborough Gas & Electric Co. in 1902.

Thus it is seen that when the Queensborough Gas and Electric Co. in question was incorporated the Town of Hempstead Co. was doing a gas-supply and the Queensborough Electric Light & Power Co. an electricity supply business. The new concern combined these two.

After such a preliminary survey, the first important work of the Commission was the determination of a fair value of the property actually and necessarily devoted to the business of these public utilities, and on which a reasonable return was to be earned. It was found impossible to get any adequate idea of the value from the records of the company in question. The early records of the absorbed companies were so incomplete that the financial operations and the results of operation could not be traced. It was found, for instance, that the Town of Hempstead Co. had the following liabilities on its books the day before it was taken over by the Queensborough Gas & Electric Co.:

Capital stock	$125,000.00
Bonds	150,000.00
Current liabilities	86,464.08
Surplus	15,756.63
Total	$377,220.71

There were no records showing whether money or property was received for capital stock. Of the bonds $67,000 were issued for cash, $10,000 for discounts, $50,000 for plant and improvements and $23,000 was unknown. The assets were stated to be:

Current assets	$25,990.42
Discounts on bonds	10,000.00
"Real estate, plant and machinery"	341,230.29
Total	$377,220.71

Of the last item, $148,000 could not be traced. There was nothing to show the value of the plant as it then existed, but it was believed to be in poor condition and expensive to operate.

The other constituent company, the Queensborough Electric Light & Power Co., had at the time of absorption, June 30, 1902, the following liabilities:

Capital stock	$410,000.00
Bonds	250,000.00
Current liabilities	40,635.82
Surplus and reserve	21,311.47
Total	$721,947.29

The Commission reconstructed the asset side of the accounts and secured the following figures:

Current assets	$27,462.25
Investments	20,324.76
"Franchise"	238,050.54
Discounts, commissions and premiums	24,768.75
Interest, legal expenses, "services" and "advance"	13,039.83
	45,000.00
Citizens' Lighting Co.	1,707.50
Other stocks and bonds	351,592.66
"Property and construction"	
Total	$721,947.29

Of these items, it was impossible to say how much represented actual investment in physical property and how much items like discounts, commissions, legal expenses, engineering, etc.

The status of the combined and resultant companies just before and after the combination is shown in the accompanying table, the asset side being figures reconstructed by the Commission from such records as were available:

	Combined companies. June 30, 1902.	Queens Borough Co. July 1, 1902.
LIABILITIES.		
Capital stock	$535,000.00	$2,000,000.00
Bonds, par value	400,000.00	1,600,000.00
Current liabilities	127,099.90	22,202.74
Surplus and reserve	37,068.10	.....
Total	$1,099,168.00	$3,622,302.74
ASSETS.		
Current assets	$53,453.67	$42,500.33
Investments	20,324.76	20,000.00
"Property and construction"	1,025,389.57	692,822.95
Franchises	.....	238,050.54
Discounts, commissions	.....	34,768.75
Interest, legal expenses	.....	13,039.83
Stocks and bonds	.....	1,707.50
Citizens' Lighting Co.	.....	45,000.00
Harris Process (worthless)	.....	2,655,000.00
Total	$1,099,168.00	$3,742,889.90
Less undistributed credits		120,587.16
Net assets		$3,622,302.74

Of the total assets, less than $800,000 represented the cost of the physical property, for which even an approximate figure was impossible as details were lacking for about $300,000, of the expenditure. One item is noteworthy. The minutes of the first meeting of the new company show that one, Caleb A. Burbank, turned over to the company the entire capital stock of the Queensborough Electric Light & Power and the Town of Hempstead Gas & Electric Light companies, and also a license to manufacture gas from garbage by a patent process called the Harris. In return he was to receive $1,990,000 in stock of the new company, and bonds to the extent of $1,200,000. The gas-from-garbage process was given a full trial, proved a failure and was abandoned.

Between July 1, 1902, when the business of the combined company was started, and Dec. 31, 1910, (date of complaint as to rates) there were certain increases in liabilities and assets, shown by the following condensed balance-sheet:

	Dec. 31, 1910.	Increase, 1902-1910.
LIABILITIES.		
Capital stock	$2,000,000.00	.....
Bonds	2,000,000.00	$400,000.00
Mortgage	33,000.00	33,000.00
Current liabilities	180,443.37	158,140.63
Reserves and surplus	190,322.58	190,322.58
Total	$4,403,765.95	$781,463.21
ASSETS.		
Current assets	$98,408.72	$57,208.39
Investments	.....	D 20,000.00
Prepayments & suspense	4,593.36	4,593.36
Materials and supplies	26,230.00	24,930.99
Fixed capital	4,274,532.88	714,730.47
Total	$4,403,765.95	$781,463.21

Increase in fixed capital ("plant," etc.) was paid from the sale of bonds and investments, the issuance of mortgage and bills payable, by other liabilities and accumulations from earnings for depreciation and reserves. It appeared also that Mr. V. E. Macy, the largest stockholder, advanced $105,388, which did not appear among the liabilities and which Mr. Macy did not expect to receive. Besides the figures shown, $160,685 were written off as depreciation in three years, making the total amount charged as additions in this period of operation as $980,805, $434,213 of which went to gas plant, $508,237 to electric plant and $38,354 as general property.

APPRAISAL OF PROPERTY.—Failing to find any indication of fair value of the property at the present time from the accounts, the nature of which is indicated, an inventory and appraisal were begun by engineers of the company and by Mr. E. G. Connette, of the Commission's Transportation Department. His estimate for the cost of the physical property, exclusive of land, on Dec. 31, 1910, was:

Gas Department	$707,815
Electric Department	637,724
Total	$1,345,539

The company accepted these figures. The estimate included cost of labor and materials, including sub-contractors' profit. As allowance for engineering supervision, contingencies, incidentals and general contractors' profit, the following estimates were submitted:

Gas Department	$136,345
Electric Department	126,608
Total	$262,953

The company argued for an allowance of 25% upon every item of net cost, which raised the above figures to $336,000. The Commission states that its experience through the examination of accounts and the approval of securities shows that allowances of this sort heretofore made have been too large rather than too small. It held that if a new company were to let a contract for the erection of its initial plant the contractor would receive probably the cost of labor and materials, plus 10%. Such a method, however, was held to be not generally followed throughout the life of an undertaking under progressive management, the additions and extensions from time to time being commonly engineered, constructed and supervised by the operating company itself. The Commission believed that the reproduction of this plant on one contract would show a cost much less than the figures allowed, as increases in overhead charges would be offset by economies in the purchase of materials in large quantities and by the economy of construction on a large scale.

Mr. Connette's figures cover the cost to reproduce the property new. Depreciation and present value were estimated to be as follows:

	Reproduction cost.	Depreciation.	Present value.
Gas Department	$844,160	$242,020	$602,140
Electric Department	764,332	226,660	537,672
Total	$1,608,492	$468,680	$1,139,812

The basis of these figures was accepted by the company as fair. The Commission stated, in presenting these figures, that if the allowances for depreciation were too low then the annual payment to be made for depreciation would be too low and the error would tend to be compensated. Too low a depreciation results in too high a value of the property on which to earn a reasonable return, which offsets too low an annual payment for depreciation so far as the consumers are concerned.

LAND APPRAISAL.—Land has not been included, as the questions in connection therewith were of a different character from those considered. The company owned six separate parcels of real estate, the cost of which the Commission fixed at $58,750. The value of the parcels on Dec. 31, 1910, was not easily determined, but after hearing witnesses called by the company and by its own separate investigation it fixed a value between that of the experts called by itself and the witnesses called by the company, and amounting to $186,750, including bulkheads and filling worth $13,562. The Commission ruled that it would be unfair to take boom figures and equally unfair to fix the price at what the property would bring on forced sale. Consideration was given to the fact that the property was covered with certain structures. They assumed the land as being sold for as advantageous use as could be made of it.

DEVELOPMENT COSTS.—The Commission allowed $130,000 for all items of preliminary and development expenses not included in the estimates for engineering, supervision, contingencies, incidentals and contractors' profit, and also not including interest and taxes during construction.

The Commission decided that the equated time for which taxes and interest were to be charged to preliminary and development charges was one and one-half years. It is stated that this did not mean that the whole undertaking was or would be built in that length of time from beginning to end, but that it was the weighted average of the different units into which the construction could be separated. It was held that as soon as an operating unit and a few lines were completed operation of that portion might begin, and for that portion interest and taxes were to become operating expenses. As other lines and additions were built it was held proper to charge interest and taxes to capital from the commencement of work until the property was ready for use, provided good management had been used. A weighted average of the time was taken, as it was held that the cost of each unit should enter, as well as the number of units into which the construction could be separated. It was held to be obvious that the whole cost would not bear interest even for the equated period, as funds would be provided as needed for certain apparatus which would be purchased just before operation began. The rate of interest was taken at 6% and it was considered fair to compute interest and taxes on one-half the reproduction cost plus the cost of land, preliminary and development expense. This amounted to $90,000.

WORKING CAPITAL.—An allowance of $30,000 for the gas department and $45,000 for the electrical department was made for working capital. The Commission recognized the need of such funds for the purchase of material and supplies, the payment of employees and the distribution of commodity in advance of receipts of payment. They found that the bulk of materials and supplies was purchased on 30-day credit, that labor was paid weekly or monthly and that fixed charges were met about quarterly. On the other hand, the bills were rendered weekly to large consumers and monthly to small ones, there being few large consumers. But many customers do not pay promptly and the city is three or four months in arrears. It was found that the company must carry regularly the cost of four to six weeks' operation, plus allowances for unforeseen demands and storage to prevent transportation delays in winter. The Commission rejected as the basis of working-capital allowance, the relation between current assets and current liabilities, since working capital does not vary with change in financial operation but depends on different grounds, while current assets and liabilities vary greatly from month to month, depending on meter readings, dividends declared, cash balances, etc.

"GOING VALUE."—The representatives of the company argued for a substantial capitalization for going value of the property (1) because it was adjusted and unified; (2) because the company had a clientele, established connections and standing in the community; (3) because valuable experience and data had been accumulated; and (4) because the early years of expected losses had been passed.

The Commission rejected the principle of allowing a going value on the ground that while these factors might be considered in condemnation proceedings, they were not applicable to this case of rate adjustment for several reasons: (1) since the claimed adjustment and unification had been amply allowed for under the heading preliminary and development expenses and in the appraisal of the property; (2) since the clientele and position in the community were that of a monopoly, the franchise had no value for good will, etc.; (3) since the information and experience is personal with the manager or superintendent, and does not go with the property; and (4) since many elements included under going value are transitory or recurrent. The Commission held that each replacement of machinery required adjustment and adaptation; that data had to be kept up to date; that advertising must be continuous, and that the testing of new methods and inventions had to continue for good management. So far as transitory elements of going value called for annual expenditure, they should be charged to operating expense for a sound and prudent course, and the company should be allowed to charge rates that will yield a sufficient income to cover such, above a fair return on fair value of property in service. The Commission considers this question in relation to the first years of operation, when a company might not earn a fair return. It held that fine-spun distinctions about capitalization were to be discarded and that the company might better charge in later years rates sufficient to offset deficiencies below a fair return in the first few years. It rejected the capitalization of these early deficiencies because it was accompanied by the use of money from stocks, bonds or notes to pay dividends and current expenses where it was not possible to clearly define the portion which might be theoretically charged as making a going concern and as normal operation.

CAPITAL FOR FUTURE DEVELOPMENT.—The company asked for the inclusions of expenditures required by the company in the way of improvements and betterments for the immediate

future, divided into (1) repairs and replacements; (2) extensions and additions for future consumption and (3) additional plant to improve service. The Commission allowed only the third item to be included under the fair value of property to receive a fair return from the present income. It held (1) that repairs and replacements should be charged against earnings and (2) that plant for future consumption should, and undoubtedly would, earn a fair return on the cost of the addition and would provide an additional profit on pre-existing plant. The Commission held that it was unreasonable to require customers to pay rates which provided funds for plant becoming the property of the company. Such plant and property should be paid for out of capital, and the Commission held that it was immaterial whether or not the stockholders relinquished a share of their dividends to increase the value of the property. There the Commission follows the opinions of Commissioner Prouty in the railroad rate cases (20 I. C. C. Rep. 265-8) bolstered by decisions of the Supreme Court.

In allowing the claim of funds for additional plant to improve service, the Commission found that the present gas and electric equipment was not sufficient to afford proper service.

UNIMPAIRED INVESTMENT.—Before fixing the sum finally on which a fair return was to be earned, the Commission investigated again all the available data of constituent concerns to study the question of unimpaired investment which was not shown definitely by the books and records. This was approached in several ways. First, from the company reports as follows:

The "fixed capital" (plant, etc.) on the account books of the company on Dec. 31, 1910, was	$4,274,532.88
Stated accrued amortization of capital.	105,421.23
Net remaining	$4,169,111.65
Deducting securities issued at time of acquiring Harris process, less undisturbed credits at time of merger.	3,559,802.41
Outlay from July 1, 1902, to Dec. 31, 1910	$609,309.24
Cost of real estate and improvements for predecessor companies as reported to Tax Commissioners	$787,339.83
Total	$1,396,649.07

Secondly, starting with the recorded investments of the two constituent companies before consolidation, the additions since consolidation were added as in the following figures. It is noted that the Harris process for making high-candle-power gas out of garbage has been omitted, as it is valueless:

Town of Hempstead Co. on June 30, 1902, had on its books for real estate, plant and machinery, deducting discounts	$341,230.29
Additions, betterments and replacements to Dec. 30, 1910 ($507,864.56, less $54,474.32 withdrawals and credits)	453,390.24
Total for gas property	$794,620.53
The Queens Borough Electric Light & Power Co., on its books June 30, 1902, had property and construction, Citizens' Lighting Co. interest, legal expenses, etc.	$409,632.49
Additions to electric plant to Dec. 30, 1910 ($561,317.22, less $33,902.57 withdrawals, credits, etc)	527,414.65
Total for electric property	$937,047.14
Total for both properties	$1,731,667.67
Depreciation written off and accrued on books	266,107.19
Net investment according to books	$1,465,560.48

Thirdly, taking, in place of the preceding figures for depreciation, the estimates of the Commission's engineer, a different figure is found for the net investment, as shown below:

Total outlay as above	$1,731,667
Accrued depreciation, Mr. Connette's estimate	468,680
Net investment	$1,262,987

Fourthly, the actual investment of the present owners was used as a starting point:

According to the data presented by the company, the present owners paid in cash or assumed liabilities for the gas property to the amount of	$268,308.51
Adding the net amount of additions, betterments and replacements down to Dec. 31, 1910, stated	453,390.24
The total outlay to Dec. 31, 1910	$721,698.75
For the electric property, the present owners invested or assumed obligations to the amount of	$667,493.90
Which includes $250,000 paid for common stock that was issued for "franchises." Adding net increases for additions, betterments and replacements, as stated	527,414.65
The total outlay to December, 1910	$1,194,908.55
The grand total for gas and electric property becomes	$1,916,607.30
Accrued depreciation, estimated by Mr. Connette at	468,680.00
Total net investment	$1,447,927.30

This is distributed as follows: Gas plant, $479,679; electric plant, $968,248. Deducting the stock called "franchises," the total becomes $1,197,927, and the electric plant, $718,248.

After considering the factors as set forth above, the Commission determined that the company was entitled to a fair return on the following amounts:

Gas plant	$860,000
Electric plant	800,000
Total	$1,660,000

FAIR RETURN.—Having settled the question of fair value, the Commission then took up the no less troublesome question of the fair rate of return. The basis applied in this case is that the rate should be such as to induce investors to provide funds with which to construct and extend a gas and electric plant within the area in question.

The Commission holds that a public-service corporation would be conservatively financed if from one-half to two-thirds of the funds required were secured by first mortgage bonds and the remainder by capital stock. In the case considered it was believed that one-half of the cost of the plant could be raised by 5 or 6% bonds and that a return of 8 to 10% on the stock would be sufficiently attractive.

The company argued that, since no allowance for going value had been made in fair value, a further allowance should be made in the rate of return if the plant did not earn a fair return in the early years. It was ascertained that just previous to consolidation the electric company paid 5% on common stock, 6% on preferred, all fixed charges and left a surplus in its treasury of 4% on $1,000,000. The gas company's net earnings were devoted to improvements, and the gas company was rated at an equal value to the electric company. The Commission held that since the electric plant had been operated as early as 1898 and the gas plant as early as 1894, there had elapsed sufficient time for the company to recoup its early deficiencies, and that it was doubtful if the present consumers should be burdened for that reason.

The Commission rejected the suggestion that, as sufficient amount had not been set aside until recently for depreciation, the rates should be so high that depreciation in past years would now be made good. Failure to provide for adequate depreciation in the past the Commission held to be the fault of the management and that probably the stockholders received what would have been used to meet depreciation, so that the present consumers should not be burdened on that account. The Commission followed in this point the opinion of Mr. Justice Moody in the Knoxville (Tenn.) water case.

Finally, the Commission fixed a return of 8% on the fair value established as being a fair rate of return. This would be equivalent to a dividend of 10% on stock and one-half the fair value and 6% on bonds for one-half fair value.

Having fixed both the fair value of property and fair return to be secured, the Commission proceeded to estimate the earnings and expenses as a basis for apportioning the prospective return on the actual service. The probable consumption on the basis of previous years, rate of growth and current conditions were estimated for the current year to be at least 177,200 M. cu. ft., and 2,820,000 KW.-hrs. of electric energy. Owing to leakage and various losses between the generating plant and the meters, the average percentage of unaccounted gas during the last five years has been about 15, and in only one year has it exceeded that. The electrical losses appear to be about 32%. On these bases it was estimated that about 208,500 M. cu. ft. of gas would have to be made and 4,150,000 KW.-hrs. would have to be generated.

The Commission recognizes that local conditions in the area in question are peculiar in that the population is sparse and fluctuating, there being in the Far Rockaway section a large summer and a small winter population, with the result that large amounts of plant remain idle during eight or ten months and unusual expenses are incurred. The Commission does not attempt to assess heavier charges against the short-period customers for the benefit of the permanent residents. It has grouped all operating charges together and apportioned them according to the amount of gas manufactured and electric energy generated. The operating expenses are given as follows, according to the experience of the company:

Gas Department.

Cost to manufacture 208,500 M. cu. ft., at 34 cts. per M. made	$70,890
Other operating expenses (including taxes but excluding depreciation), 177,200 M. cu. ft., at 30 cts. per M. sold	53,160
Depreciation and other reserves	25,000
Return on fair value of property ($860,000 at 8%)	68,800
Total	$217,850

Electric Department.

Cost of generating 4,150,000 KW.-hrs. at 1.7 cts. per KW.-hr.	$70,550
Other operating costs (including taxes but excluding depreciation), 2,820,000 KW.-hrs. at 2.8 cts. per KW.-hr. sold	78,960
Depreciation and other reserves	28,000
Return on fair value of property ($800,000 at 8%)	64,000
Total	$241,510

The income not effected by the maximum rate to be imposed is found to be as follows:

Gas Department.

Public lighting, 7,200 M. cu. ft., at 75 cts. per M.	$5,400
Private street lighting, special contracts	3,800
Gas jobbing, etc.	1,800
Rent of rooms in office building (one-half total)	
Increase in value of land	11,000
Total deductions	$22,000

Electric Department.

Street lighting, 800,000 KW.-hrs., at 6 cts.	$48,000
Municipal bldgs., 20,000 KW.-hrs., at 10 cts.	2,000
Commercial power, 700,000 KW.-hrs., at 4 cts.	28,000
Electric jobbing, etc.	1,400
Rent offices	1,000
Increase in land values	6,300
Total deductions	$86,700

This secondary income, if it may be so termed, is subtracted from the operating cost, and the difference is divided by the quantities sold to give the rate which is judged reasonable. On the basis of sales of 168,200 M. cu. ft. under the maximum rate to be imposed, the unit rate works out at slightly over $1.16. On the basis of a consumption of 1,300 KW.-hrs. at the rate to be imposed, the unit price works out at an average of over 12 cts. per KW.-hr. In fixing the price in the final order of the Commission to the company, these figures appear as the basis, but the Commission seems to hold that the operating conditions are apt to improve, due to an increased stability of population in the district, and the gas rates are made progressively diminishing.

ANNUAL DEPRECIATION.—In the above figures of annual expense, the items of depreciation and increase in land value are seen. The Commission takes pains to comment on its use of these items. The depreciation is based on the following mathematical deduction:

	Gas Dept.	Electric Dept.
Cost to reproduce (excluding land)	$844,160	$764,332
Deduct scrap value of	75,538	80,274
Wearing value (to be amortized)	$768,622	$684,058
Period of service (average)	25 years	20 years
Annual depreciation—straight line	$30,231	$34,343
Rate to amortize (4% sinking fund)	0.02401196	0.03358171
Annual contribution (4%)	$18,456	$22,972
Annual contribution (5%)	$16,105	$20,688

It is stated that experience has shown that the straight-line method of providing for depreciation reserves provides a larger fund than necessary, since some portion of the annual loss is

made good by renewals and covered by the operating expense there.

The system of accounting prescribed by the Public Service Commission defines repairs as structural charges which do not amount to a substantial change of identity. The Commission has ruled that renewals of electric line, poles, wires, etc., shall be included as maintenance, as it would be unduly troublesome to demand separate records of each pole or length of wire. It is held that fully one-fourth of the straight-line depreciation of this electric plant ($8,500) proceeds from poles, fixtures, etc. In the year 1910 the company expended for renewals and replacements of gas plant, not covered by maintenance, only $1,306. It is believed that annual expenditures for replacements are likely to be small at present and that any fund set aside could be invested and interest compounded. The annual contribution to take care of all replacements in accordance with the figures presented above would be only $40,000. If the company invested the fund in its own property, giving a fair return of 7 or 8%, the amount set aside would be less than $29,000. It is the Commission's experience that the sinking fund will not accumulate as rapidly as the tables indicate and, as there are unforeseen occurrences which should be allowed for, the Commission has increased the bare figures of depreciation considerably.

The Commission has followed the decision of the U. S. Supreme Court in the Consolidated Gas case in using the present value of land in finding a fair value of the property to receive a fair return. It holds, however, that in so doing it is bound to include in the receipts of the company the annual appreciation of the land. It argues that where depreciation in buildings and plant represents a decrease in assets placed as a debit against operation, then it is only logical to apply the converse of the idea. It holds that if the consumer is to be burdened with a rate which ... a fair return on appreciated value of land, then he is to be relieved by including in the receipts the annual appreciation. The Commission considers that the annual increment is no more indefinite than the total increment or present value and that if the present value can be determined the annual appreciation can be determined. Just as payments to the depreciation fund are not actually expended and yet are considered legitimate charges against operation, similarly, while annual increments in property do not represent cash income, still the value is held to be there and is properly a credit. If the property is growing more valuable and if the state recognizes a right to earn a fair return on such increase, the investor has no cause for worry. The existence of such an increase not covered by securities is considered an element of safety, being a valuable reserve.

ORDER.—The order of the Commission, in accordance with the foregoing opinion, is as follows:

The maximum prices to be charged for gas and for electricity in the Fifth Ward of the Borough of Queens, City of New York, by the Queensboro Gas & Electric Co. shall be as follows:

From July 1, 1911, to Jan. 1, 1912, $1.20 for 1,000 cu. ft. of gas.

From Jan. 1, 1912, to July 1, 1912, $1.15 for 1,000 cu. ft. of gas.

From July 1, 1911, to July 1, 1912, 13 cts. per KW.-hr. of electricity.

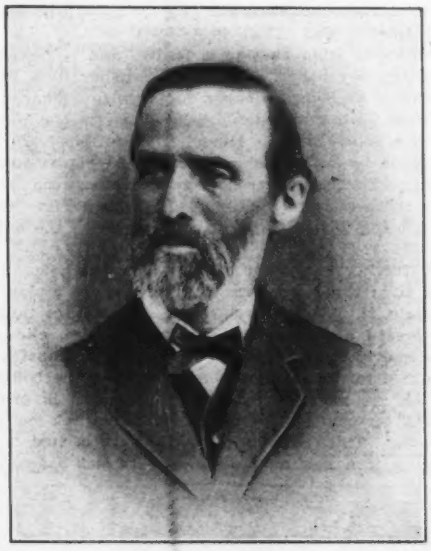
The Wachusett Dam Power Plant of the Metropolitan Water Works of Boston, Mass., has at last been completed and power generated. On Aug. 10 the Chief Engineer of the Metropolitan Water Works threw the switch which sent out the first current from the generators. The power is sold by the state to the Connecticut River Transmission Co., which in turn resells the larger part of it to the Lancaster Mills in the town of Clinton, Mass. The power is generated by the water passing from the reservoir into the aqueduct. Although the plant was authorized by act of the legislature in 1895 and the power-house completed at the time the dam was completed, the turbines and electric generators were not installed until recently. The Wachusett dam and reservoir system were described in Engineering News of Sept. 13, 1900, by Mr. A. D. Flinn, M. Am. Soc. C. E.

Francis Collingwood.

The death of Francis Collingwood on Aug. 18, following soon after that of the late Edward P. North, removes another old-time engineer whose membership in the American Society of Civil Engineers dated back to the time of its reorganization. Mr. Collingwood had been a member of the society since March 3, 1869, or for more than 42 years. Of the 160 members of the society at the beginning of 1870, but 32 now survive, of these, one, the venerable William Douglas Pickett, of Lexington, Ky., is a charter member, having joined the society in 1853.

Francis Collingwood was born in Elmira, N. Y., on June 10, 1834. His early education was received in the schools of that city, and when 17 years of age he entered Rensselaer Polytechnic Institute at Troy, from which he graduated with the class of 1855. Among his contemporaries there was Mr. Washington A. Roebling, who succeeded his father, John A. Roebling, as Engineer of the Brooklyn Bridge between New York City and Brooklyn.

Mr. Collingwood was City Engineer of Elmira from 1865 to 1869, and Assistant Engineer in the construction of the Brooklyn Bridge from 1869 to 1883. It was during this period that he became a member of the American Society of Civil Engineers and we find his name frequently mentioned in the early volumes of its Proceed-



Francis Collingwood

ings. He was not only a frequent attendant at the meetings, but contributed to the discussion of some 63 papers. He was himself the author of 12 papers, many of them describing various parts of the construction of the Brooklyn Bridge. Among his papers is one presented in 1885 on "The Preservation of Forests" in which he summarized the forestry operations up to that time and called attention to the necessity of economical methods of lumbering if the forests were to be saved from rapid extinction.

After the close of his work on the Brooklyn Bridge he was engaged to supervise repairs to the Allegheny suspension bridge between Pittsburgh and Allegheny, Pa. This bridge had not been examined for 25 years and repairs required a considerable time. In 1887 he was appointed Chief Engineer of the Chesapeake Dry-Dock & Construction Co., at Newport News, Va. In 1888 he returned to New York City and was appointed a member of the new Croton Aqueduct Commission, which examined and reported upon the reservoir and aqueduct work recently completed for the city of New York. In 1889 he was appointed by the city of Elmira to make an examination of the Chenung River to devise means for protecting the city from floods.

He was elected Secretary of the American Society of Civil Engineers in 1891 and served in this capacity until 1894. In 1895 he was made Expert Examiner for the New York City Civil Service Commission which position he held until a short time before his death. During the same period he was also a lecturer on foundations at New York University and a consulting engineer with offices in New York City. For many years he made his home in Elizabeth, N. J.

Mr. Collingwood was an associate of the American Institute of Mining Engineers, an honorary corresponding member of the American Institute of Architects and a member of the Institution of Civil Engineers of Great Britain. As a member and contributor to the Transactions of the last-named society he was awarded the Telford Medal in 1884 for a paper describing the repairs to the Allegheny bridge (abstracted in Engineering News of Aug. 2, 1884), and at another time was awarded the Trevithick Premium. He was a director of the American Society of Civil Engineers from 1873 to 1876, and was the founder of the Collingwood Prize for Juniors.

Additional Control Over Stream Pollution, sewerage and sewage-disposal systems in New York State has been granted to the State Commissioner of Health by recent amendments to Chapter 49 of the Laws of 1909 (Chapter 45, Consolidated Laws). While several of the existing sections have been amended, these amendments are chiefly for the purpose of bringing the Act as it previously stood into accord with new section, which we are informed is substantially as follows:

Order to discontinue pollution of waters. Whenever the State Commissioner of Health shall determine upon investigation that sewage from any city, village, town, building, steamboat or other vessel, or property, or any garbage, offal or any decomposable or putrescible matter of any kind is being discharged into any of the waters of the state, which shall include all streams and springs and all bodies of surface and ground water, whether natural or artificial, within or upon the boundaries of the state, and when, in the opinion of the State Commissioner of Health, such discharge is polluting such waters in a manner injurious to, or so as to create a menace to health, or so as to create a public nuisance, he may order the municipality, corporation or person so discharging sewage, refuse or other matter, to show cause before him why such discharge should not be discontinued. A notice shall be served on the municipality, corporation or person so discharging sewage, refuse or other matter, directing such municipality, corporation or person to show cause before the said State Commissioner of Health on a date specified in such notice why an order should not be made directing the discontinuance of such discharge. Such notice shall specify the time when and place where a public hearing will be held by the State Commissioner of Health and notice of such hearing shall be published at least twice in a newspaper of the city, village, town or county where such discharge occurs, and shall be served personally or by mail at least 15 days before said hearing and in the case of a municipality or a corporation such service shall be upon an officer thereof. The State Commissioner of Health shall take evidence in regard to said matter and he may issue an order to the municipality, corporation or person responsible for such discharge, directing that within a specified period of time thereafter such discharge be discontinued, and such proper method of treatment or disposal of such sewage, refuse or waste matter be adopted as will permanently obviate such pollution of said waters by the municipality, corporation or person responsible therefor and as shall be approved by said commissioner. Such order shall not be valid until approved by the Governor and the Attorney-General and when so approved it shall be the duty of the Attorney-General to enforce such order. Such means or method for the treatment or disposal of sewage, refuse or other matter must be executed, completed and put in operation within the time fixed in the order. The State Commissioner of Health shall have authority to require from the officials and persons responsible for the execution of such orders satisfactory evidence at specified times of proper progress in the execution of such orders, and may stipulate and require that certain definite progress shall be made at certain definite times prior to the final date fixed in the order. For the purposes of this article sewage shall be defined as any substance, solid or liquid, that contains any of the waste products or excrementitious or other wastes or washings from the bodies of human beings or animals. But this section shall not apply to refuse or waste matter from any shop, factory, mill or industrial establishment not containing sewage as hereinbefore defined.

Besides bringing other portions of the Act into line with the new section, further amendments make more specific and forcible the modes of procedure to be followed in the prevention of stream pollution. Effluents from sewage-disposal plants are by the amendments brought within the jurisdiction of the Commissioner.

It should be noted that the additional powers conferred upon the Commissioner of Health can be exercised only with the concurrence of the Governor and Attorney-General in case of an order to discontinue the discharge of untreated sewage into the streams of the state; also that the new section does not include trades wastes unless they contain sewage.

Recent Developments of the Suction Conveyor.

By W. G. HUDSON,* M. Am. Soc. M. E.

In Engineering News, of April 8, 1909, the Darley suction-type of ash conveyor was described, as it had been successfully used in several industrial power plants. It will be remembered that the great advantage secured was the elimination of moving parts in contact with the corrosive ashes. The system was shown to have extreme simplicity, consisting essentially of (1) a conveyor duct with ash inlets, (2) a water jet for sprinkling the ashes to reduce heat and dust, (3) a storage tank, (4) an exhaust pipe and exhausting blower.

The development of the Darley suction conveyor historically is an interesting record of achievement in the face of discouraging difficulties. The first attempts to work out a satisfactory system date back some 20 years. As first evolved, pressure blowers were employed instead of exhausters. Steam jets were tried both as exhausters and blowers; in fact, the marine steam-jet ash ejector is one phase of the principle which was developed independently and successfully by others. It was found impossible to use this method satisfactorily in a long duct with numerous intakes, because of abrasion, condensation, and clogging. Finally, with the germ of the present design, several installations were made which were reasonably satisfactory in operation, though wasteful in power-consumption and rather limited in capacity.

Three years ago, when it became apparent that the scheme was practicable and that the idea was sufficiently attractive to engineers who were acquainted with the difficulties involved in handling ashes to insure a market, the problem was attacked energetically, and the system brought to a commerical basis. A contract was received from the Government for a conveyor to handle the ashes at the central power plant of the League Island Navy Yard, and proved eminently satisfactory. This was followed by installations at the Brooklyn, Charleston and Norfolk yards, and at numerous large industrial and street-railway power plants.

Several details have been improved over the design shown in the earlier article in Engineering News. For instance, a dust collector has been placed in the exhaust pipe between the ash tank and blower; the water spray has been placed further back from the tank in the conveyor duct with increased effectiveness of quenching; and there has been considerable development of the constant pressure exhauster.

The final development has been in adapting it to handling coal cement clinker, and similar material, and several interesting installations have been made. This conveyor is made up ordinarily in three sizes, with 6, 8 and 10-in. carrying ducts having capacities variously ranging from 150 to 600 lbs. per min. These figures apply particularly to ash handling and, as coal is more readily carried than ashes, the standard sizes have materially larger coal-carrying capacities, say from 40% to 50% greater.

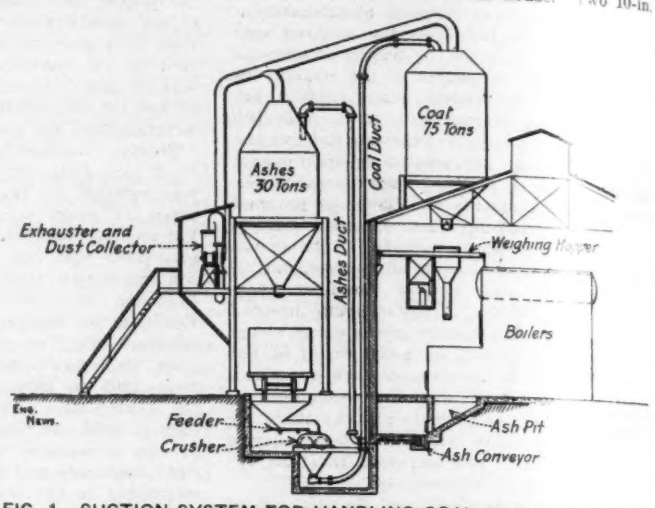


FIG. 1. SUCTION SYSTEM FOR HANDLING COAL AND ASHES: BALDWIN LOCOMOTIVE WORKS, EDDYSTONE, PA.

Fig. 1 shows the general arrangement of the equipment at the central power plant of the Baldwin Locomotive Works, Eddystone, Pa. Coal is discharged from cars to a feeder, and is passed through a crusher. From the crusher it is received in an 8-in. conveyor duct which discharges it to a 75-ton coal tank located above the roof of the boiler house. Distribution to the boilers is made by means of a 5-ton capacity traveling crane. The exhauster is connected also to a 30-ton ashes storage tank, the ash conveyor in this case being located flush with the floor in the ash tunnel.

A further extension of this idea is shown in Fig. 2, at the Pierce-Arrow Motor Car Co.'s plant, Buffalo, N. Y. In this case the coal-storage tank is located at one end of the boiler house, and a motor-driven car of five tons capacity transfers the coal to the overhead bunker within the boiler house. A reserve storage of 3,000 tons is provided by continuing the motor car track on a trestle. This reserve storage is reclaimed by means of a suction duct in the tunnel beneath. Bituminous slack is handled at this plant, therefore no crusher is provided.

Perhaps the most interesting instance of this kind is shown in Fig. 3, exhibiting the equipment now in course of erection at a large industrial plant, where coal is received from the siding some 500 ft. away from the boiler house. Two 10-in. suction coal conveyors are arranged to deliver the coal to storage tanks above the roof of the building, the coal-handling capacity being 50 tons per hour. Coal is distributed in the storage bunker by means of a motor-driven car, and from the bunker to the stokers by a 5-ton traveling weighing crane. Two exhausters are used, and arranged so that either can operate the system. They are also connected with the ash-handling system for removing ashes from the basement of the building. The boiler capacity in this building is 10,000 HP.

It should be noted that the "separator" tanks seen in the accompanying figures are only for the separation of the coal from the air, which serves as carrier. To prevent breaking the suction, when coal is dumped from these tanks, two valves are used—one above and one below an auxiliary receiver. This forms a sort of air-lock into which the coal first passes before discharging.

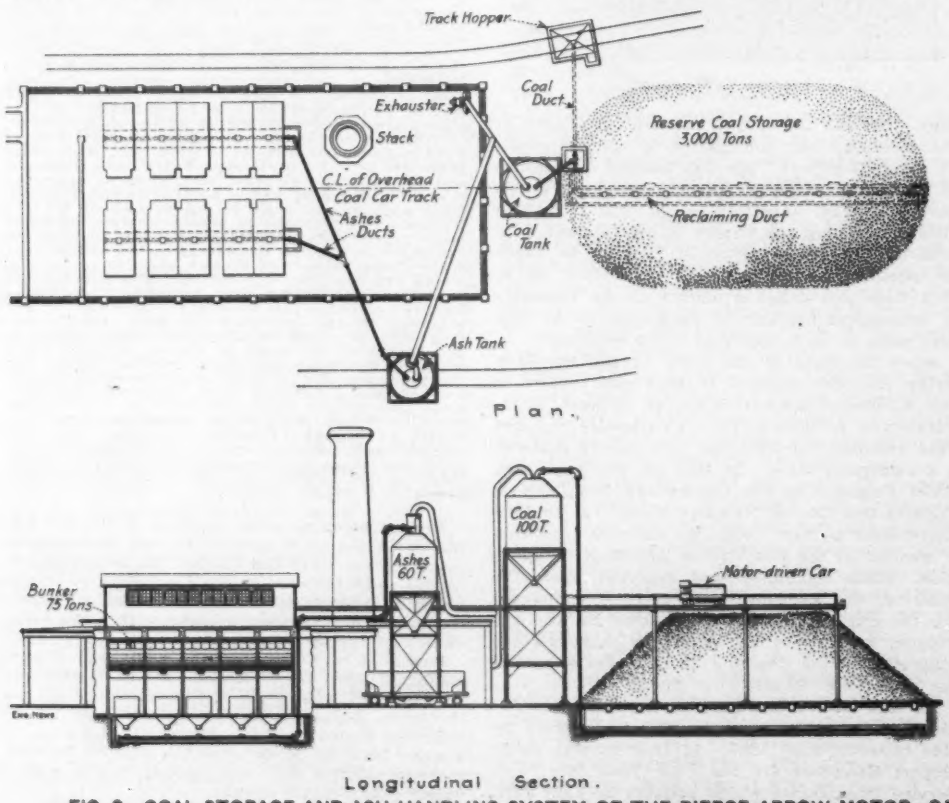


FIG. 2. COAL STORAGE AND ASH HANDLING SYSTEM OF THE PIERCE ARROW MOTOR CAR CO., BUFFALO, N. Y.

A Novel Use for an Industrial Railway has been found in Pittsburgh, Pa. The baseball park there, at Forbes Field, has recently been converted into an open-air hippodrome for performances following the afternoon baseball games. For this purpose it is necessary to erect each afternoon three large wooden stages, two rectangular and one round in shape. The rectangular stages are 21 × 50 ft. each, built in 10 sections of 21 × 5 ft. each. Each section weighs about 1,100 lbs. The circular stage is much larger and composed of 20 sections. When not in use these sections are stored under one of the field stands. At first the stage sections were moved each day by horses and wagons. But this method was slow, cut up the diamond with wheel ruts, and was damaging to the stages. A solution was found by installing an industrial railway with a portable track. The track is 2-ft. gage made in 15-ft. sections with 16-lb. rails and flat steel ties; these sections are light and easily and quickly put together. Forty 600-lb. steel flat cars of special design are provided. Each car has capacity for a 1,100 lb. stage section. Two cars can be handled on the level track by one man. Enough cars are used to hold all the sections so that when removed to the storage place it is not necessary to unload the cars. The time of erecting the stages were reduced in this way from three hours to one hour. The scheme is the joint product of the Hippodrome management and the Orenstein-Arthur Koppel Co. of Pittsburgh, who manufactured the equipment.

*Vice-President, Guarantee Construction Co., 140 Cedar St., New York City.

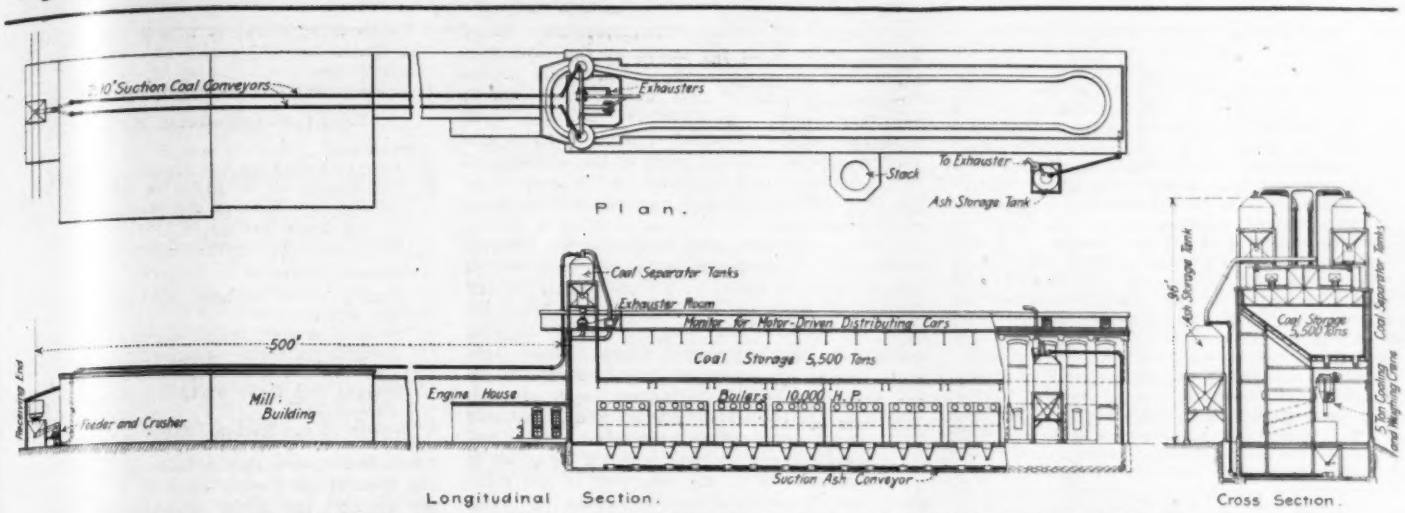


FIG. 3. PNEUMATIC COAL AND ASH HANDLING EQUIPMENT OF A 10,000-HP. BOILER HOUSE.

Report on the Explosion of an Acetylene Generator Supplying Oxy-Acetylene Welding Apparatus.*

An automatic acetylene pressure generator owned by the Worcester Welding Co., of Worcester, Mass., exploded on the afternoon of June 8, 1911, entirely demolishing the small building in which it was housed. In a special report made for the National Fire Protection Association, an abstract of which follows, the explosion is ascribed to the failure of the generator's safety-valve, which was of the type actuated by a rawhide diaphragm.

This generator was housed in a reinforced-concrete building 7 × 9 × 8 ft. This building had a galvanized-iron roof and was situated 21 ft. from the nearest buildings. The concrete walls, constructed of angle iron with steel lath, were about 2½ ins. thick. As a result of the explosion, these walls were laid flat, not being carried more than 8 ft. from their original location. The corrugated iron roof was carried to the west a considerable distance, and the cover of the generator was carried to the east over a small building, a distance of 75 ft. The greatest damage was done by the metal-covered wooden door of the building which was thrown against the piazza post of a frame house 21 ft. away, in such manner as to cause the piazza to collapse and spring the rear end of the house, necessitating considerable repairs. Windows were broken in many directions, but there was no serious damage other than that mentioned. No one was hurt, and no fire was caused by the explosion.

The use of the oxy-acetylene blow-pipe in the United States has a history of less than four years. The rapidity of the introduction of the process demonstrated the necessity of adequate rules and regulations governing the installation and use of its apparatus, as in the case of systems of generating acetylene gas for house illumination. The rules and requirements of the National Board of Fire Underwriters for the construction, installation and use of oxy-acetylene heating and welding apparatus, were published late in 1910. In the meantime a large number of oxy-acetylene generators had come into use, which did not comply in detail with the new rules and requirements. The generator which exploded in Worcester belonged to a type manufactured and tentatively permitted prior to the adoption of the rules, and other models now put out by the same company differ in many particulars from the one which exploded in Worcester, and have been tested after examination by the Underwriters' Laboratories.

In order that the cause of the explosion may be understood it is necessary to state something of the nature of calcium carbide and acetylene. Calcium carbide consists of calcium and carbon chemically united by means of the electric furnace. The carbide itself will neither burn nor explode; nor is it affected by concussion in any way. It may be subjected to any temperature less than that of the electric furnace without any material change in its character. When, however, it is brought into contact with water, the affinity of the calcium for the oxygen in the water manifests itself and the carbon is released to join the hydrogen, forming the hydro-carbon acetylene, a gas of extreme richness. The residue is inert and consists simply of slacked lime.

The method of generation in the case of the generator which exploded is to drop the carbide by means of a clockwork mechanism, regulated automatically, into a large volume of water, the resulting gas accumulating in the generator until a pressure of about 8 lbs. per sq. in., with a limit of 15 lbs., is reached. [See Eng. News, Nov. 19, 1908, p. 547, for description of a generator of this type.—Ed.]

Acetylene acts like any ordinary gas in all particulars save one. Other gases in ordinary use can be compressed to liquefaction without changing their nature in any respect. Acetylene, however, when compressed to approximately two atmospheres, acquires properties which it loses again when the pressure is withdrawn. Acetylene under atmospheric pressure, without an admixture of air or oxygen, will not ignite or explode, even with the application of the electric spark. When, however, acetylene under atmospheric pressure is subjected to a high temperature, the molecules in contact with the hot surface polymerize into other substances, and if the temperature is high enough, into the original elements of hydrogen and carbon. This change is, however, local, and may go on indefinitely; so that acetylene in the presence of a hot surface is not dangerous until by compression to approximately two atmospheres the molecules are brought sufficiently close together so that the disassociation of one is transmitted to the other. When this point is reached all the acetylene under pressure will disassociate with explosive violence.

The problem, therefore, to be solved in the case of the pressure generator for oxy-acetylene purposes is to provide a safety device which will strictly limit the pressure to the standard, which is 15 lbs. to the square inch. This 15 lbs. to the square inch leaves a large margin of safety. Reliable safety valves are already available and have proved themselves dependable in connection with oxy-acetylene apparatus. Generators limited to a pressure of 15 lbs. should be as safe from disassociation as the house generator with its ounce or two of pressure has proved itself to be. In the case of the house generator, there is no record of an internal explosion without an air mixture. The house generator has withstood exposure by fire without losing its gas, and without any explosion from the heat.

In the case of the generator in Worcester, the generator itself is intact and water tight. When first examined, it was found that it still contained a quantity of water, together with the residue. The generator itself is not distorted in any way. The steel cover of the generator on which the clockwork was located was, however, torn off, severing 24 ½-in. bolts. The cover is crimped at one point, indicating that one bolt gave way, followed by a tearing action on the others. The clockwork of the generator has not been recovered, and it is presumed that it was carried off by children. The fact that the cover, with its heavy bolts, was torn from the top indicates clearly that the internal pressure in the generator did not rise slowly; for had it done so, other parts of the machine less strong would have yielded first. All the indications point to a disassociation of the gas, which struck so violent and sudden a blow upon the cover that it tore it from its fastening, while the water below protected, by its inertia, the bottom of the generator, which normally should have yielded first.

It appears that the explosion had its inception in the carbide hopper and this protected the sides of the generator above the water, although this point, of course, could not be definitely ascertained. The machine had been used during the forenoon and had been recharged prior to the noon hour, when it was put out of operation. Shortly after one o'clock the machine was put in operation again, the blow-pipes were made ready for use and some gas was drawn off. The blow-pipes were not in use when the machine exploded, and had not been for some time. It is probable there was considerable after-generation, and it is probable that the machine fed considerable carbide immediately prior to the shutting off of the blow-pipes. The carbide was fresh when put into the generator, and as it was taken from the bottom of a drum, it probably contained considerable fine carbide. The machine having been used during the morning, probably slowly cooled, and the water of condensation undoubtedly attacked the carbide in the hopper, adding somewhat to the generation of gas. The indications of probable after-generation under the methods of use by the Worcester Welding Co. are shown by the fact that a locking device attached to the safety valve, which will be mentioned later, had on several previous occasions operated, showing that the safety valve had acted on previous occasions.

There was apparently no escape of gas into the building, or explosion outside the generator. The cause of the disaster was the rise of pressure above the point of disassociation of acetylene in the interior of the generator, accompanied by a rise of temperature in the carbide, owing to the water of condensation, or to some drops of water falling upon the carbide in such a manner as to raise the temperature locally above the point where disassociation in the acetylene takes place. The failure of the safety valve which permitted this rise in pressure is responsible for the trouble. It has been ascertained that the blow-off pipe to which the safety valve is attached would be entirely capable of carrying off the acetylene as fast as the clockwork could produce it, without an undue rise in pressure. Therefore, the question resolves itself into the construction of this particular safety valve.

The safety valve was an aluminum disk seated upon a soft rubber ring. The disk was about 1 in. in diameter and the aperture in the rubber ring was a little over ½-in. This disk was attached to a valve stem which carried a rawhide diaphragm. The inside dimensions of the diaphragm were about 3 ins. Underneath the diaphragm was a metal disk designed to support it, and above was an extension of the valve stem which held the diaphragm in place. The annular space between the disk holding the diaphragm and the outer edge of the cast-iron case was slightly over ¼-in. The soft rubber ring on which the safety valve disk rested was of such a character that it would follow the disk for a short distance when the safety valve moved to release the gas. The rawhide had been subjected to the action of the lime dust which was carried by the unpurified acetylene and had hardened.

In addition to this combination which belongs to the safety valve proper, a series of levers had

*Abstracted from the July, 1911, "Quarterly" of the National Fire Protection Association.

been attached to the safety valve containing nine moving joints which were designed to shut off the clockwork as an emergency stop when the safety valve moved to release the excess of pressure. The sticking or displacement of any of these moving joints would cause the safety valve to fail to operate, and the use of rawhide under the circumstances may in itself have interfered with its operation. The following of the safety-valve disk by the rubber on which it rested may also have caused trouble. It is impossible to state exactly what happened except that the safety valve certainly failed to work. There was a consequent rise in pressure and it happened probably at the same time there was a piece of hot carbide in contact with the acetylene. Following the law of its nature, the compressed acetylene disassociated, with the results recorded.

Future explosions of the same character should be avoidable by the selection of a safety valve which will operate and which will not deteriorate, and which may not be used as a device to operate other mechanisms. A double protection might be afforded by two valves, one a check upon the other, attached to separate openings in the shell of the machine. The explosion in Worcester would seem to have no other significance than the demonstration of the imperfect character of the safety valve in use on that particular machine. The adopted standard of 15 lbs. per sq. in. as the limit of practical safety in the use of acetylene pressure generators allows an ample margin of safety. The need of providing an adequate and satisfactory device to limit this pressure, one which will operate under all conditions, is the lesson to be drawn from the Worcester explosion.

The International Navigation Congress.

By E. L. CORTHELL,* M. Am. Soc. C. E.

One of the most important International Congresses ever held in this country will be the International Navigation Congress, which will convene in Philadelphia about the first of June, 1912. This will be the first time this Congress has ever met in the United States. This approaching meeting is the result of efforts in progress since 1899 to obtain the necessary legislation and arrange for a place to hold it in this country. Thanks to the perseverance of those most interested, it is now to meet here.

This is no ordinary congress in its scope, methods and usefulness. There is scarcely a government in the world uninterested; over forty are financial supporters of it, including our own. All of them appreciate its great usefulness. Its growth and prosperity have become phenomenal. Since its permanent organization, at the Brussels Congress of 1898, where the hitherto separate Congresses—Inland and Maritime—were united in the "International Navigation Congress," it has become one of the most beneficent factors in the promotion of the best methods of navigation as applied especially to the works of construction and maintenance of harbors, ports, rivers, canals—maritime and inland—breakwaters, jetties, docks, wharves, quay walls, dredging, appliances for handling cargo—in fact, all questions relating to facilities for the world's navigation.

These questions, many of them of paramount importance to the welfare of the world, have led logically to other questions far afield, such as the size of the ocean vessels to use these ports and ship canals, the safety appliances for their navigation, the best kind of barges for river and canal navigation, and other far-reaching problems before ship builders, navigators and engineers, and in fact all questions in which every person should be interested who has to do with commerce by water and those who have a desire to see better and more harmonious relations between transportation methods by railroad and water.

The experience of many years and long study by practical experts have evolved methods of conducting Congresses so as to make the work the most useful. Briefly they are as follows:

The papers are prepared many months in advance upon subjects selected, approved and assigned to writers in the different countries two years before the triennial Congresses meet. These papers must be in the hands of the Executive Committee at Brussels—the headquarters of the Congress—at least a year before the Congress convenes. They are translated into the three languages of the Congress, French, German and English, and distributed early to the members of the Congress in all countries—which now number over 2,000 permanent members and Government delegates.

These papers are then reviewed by General Reviewers (Rapporteurs Generaux), each one of whom makes a digest of all the papers on the "Question" assigned to him, together with his own observations and views of what "Conclusions" the Congress should adopt. These General Reports are made by Reporters selected in the country where the Congress is to be held. They also are translated, printed and distributed long before the Congress assembles. These Reports bound together form a hand book, as it were, for the use of the members of the Congress, for at the sessions no papers, not even the reports, are read, this being done by the members at their homes. The "Conclusions" are, however, read paragraph by paragraph and sentence by sentence, often even word by word, and are discussed in each section of the Congress, and they come out of the discussion modified, sometimes radically changed, always improved and crystallized into the thought and the form which the ablest experts in the world believe to be the best.

The papers—not only on "Questions" but "Communications," descriptive of the work of the world, the Reports of the General Reporters, the discussions and the final Conclusions adopted by the Congress—all are printed in the three languages and sent out to the entire membership all over the world. They form a compendium of Navigation Works every three years that is calculated to and does set the pace everywhere where there are countries on oceans and seas or where rivers and canals penetrate into interiors of the continents.

The opinions of this Congress have fixed the minimum of entrance depth at all first-class ports of the world, and the proofs can be adduced to show that the governments of two South American countries are working on the views emitted by this Congress that the entrances to all ocean ports of any importance should have at least 30 ft. depth.

The work of the Congress is not limited to its triennial meetings. Its work is continuous. Papers are published and circulated between the triennial sessions, descriptive of navigation works or discussing important questions affecting navigation. The following are some illustrations of these intermediate papers: "The Cost of Operation of Ports," "The Port of Para," "Bibliography of Rivers, Canals and Ports," "Civil Engineering at the Brussels Exposition of 1910," "History of Ship Building in the Netherlands," four volumes with 200 colored and 150 photographic plates, etc.

It has been the earnest desire of the members in other countries to hold a Congress here. The arrangements have at last been made. The Government has by Act of Congress given authority to invite the Navigation Congress and an appropriation of $50,000 has been provided to meet the necessary expenses. To this has been added an appropriation of $25,000 by the State of Pennsylvania, and the cordial support has been obtained of the city of Philadelphia, where, for many reasons, it was decided to hold the Congress.

The Questions and Communications for this Congress are briefly as follows:

First Section—Inland Navigation.

Questions.

1. Improvement of rivers by regulation and dredging.
2. Dimensions to give to canals of heavy traffic.
3. Intermediate and terminal ports of canals and rivers—best methods for combining, facilitating and harmonizing the transfer of freight between waterways and railways.

Communications.

1. Application of concrete to hydraulic work.
2. Reports on works or proposed works including the protection of banks of navigable waterways.
3. Utilization of large but shallow rivers.

Second Section—Ocean Navigation.

Questions.

1. Means of docking and repairing vessels.
2. Dimensions to be given to maritime canals, taking into account the probable dimensions of sea-going vessels of the future.
3. Mechanical equipment of ports.

Communications.

1. High-powered dredges and rock removal under water.
2. Reports on most recent works at the most important sea ports. Applications of reinforced concrete. Means of preserving it.
3. Bridges and ferry bridges and tunnels under waterways.
4. Safety of navigation. Lighted buoys.

Membership is either permanent or temporary. The dues of the former class of members are $2 per annum; the latter membership is for one Congress only and the dues are $5. Persons joining next year as permanent members also pay this latter sum. Those joining this year or any other intermediate year as permanent members pay the former sum. Requests for membership application blanks should be sent to Lieut. Col. J. C. Sanford, General Secretary International Navigation Congress, Room 344, The Bourse, Philadelphia, Pa.

Various visits of inspection are planned as a feature of the Congress, which will be of interest to members from other countries as well as to those of this country. During the Congress, which covers about a week, there will be one-day visits to New York, Washington and Philadelphia and suburbs, including the Delaware River and breakwater.

After the Congress a more extended inspection trip is proposed, comprising a daylight trip on the Hudson River to Albany, and inspection of the Barge Canal works in that vicinity, as well as an examination of plans, maps and models in the Albany office; then by special train to various points along the canal to see the movable dams on the Mohawk, Little Falls lock, the highest in the world, 41 ft. for barges of 2,000 tons, to Medina, where a most remarkable concrete arch bridge will then be under construction, and to Lockport, where the old flight of locks is being condensed into two. At this point the members will be met by the Buffalo people with a sufficient number of automobiles to visit Niagara Falls and its hydraulic works; then to the Buffalo Club on the Niagara River for dinner, and thence to Buffalo, where the following day this beautiful city and lake port will be visited, followed by a trip on a special steamer on the Great Lakes, stopping at Cleveland, Detroit, Sault Ste. Marie to see the locks and power plants, then to one of the great ore-handling dock ports, to Milwaukee, and to Chicago. Here the members will be entertained by the Commercial organizations of that city. Then from Chicago by special train on the Pennsylvania Railroad to and along the Ohio River to examine movable dams built and being built by the United States Government, and thence via Pittsburg to New York or Philadelphia, where the European members will take their special steamer, or other steamers, to Europe. For those interested there will be also special inspection trips to the Cape Cod Ship Canal, and to the Panama Canal, to the Canadian waterways and no doubt to other points.

This generally and briefly is the program of the work of the Congress and its inspections. It is attractive as a Congress of great interest and as an opportunity to examine navigation works, and for United States members to meet members from abroad engaged in similar works and interested in similar subjects to ourselves.

It is not out of place to suggest to all American engineers and to others in any way interested in navigation and water transportation, to join this Congress and to do it without delay, so as to obtain its literature and take advantage of the very low dues for permanent membership.

*149 Broadway, New York City.

A Derailment of an Express Train on the Baltimore & Ohio R. R. occurred on Aug. 28, about 48 miles east of Pittsburgh, Pa. The locomotive and three cars left the rails and plunged into a side hill. No one was seriously injured.

A Broken Rail Caused a Disastrous Derailment of an excursion passenger train on the Lehigh Valley R. R. at Manchester, between Rochester and Geneva, N. Y., on Aug. 25. The train consisted of two engines and 14 cars. It ran through the yard at Manchester at moderate speed, apparently, and just beyond reached a deck plate-girder bridge over Canandaigua outlet. About 200 ft. before the bridge was reached, on a curve, a rail broke under the train; the locomotives and the first five cars were not derailed, the next three were derailed but did not run off the roadbed, the next three went off the roadbed, and the last three remained safe. Of the three wrecked cars the first, a dining car, crossed the bridge safely but tipped over and rolled down the embankment just beyond. The next car ran off the bridge into the creek, and the forward end of the car behind also went down, this car coming to rest in vertical position against the side of the bridge. The wreck resulted in the death of 29 persons and the injury of fifty or more.

On the causes and circumstances of the accident, the Lehigh Valley R. R. Co. issued a statement to the press, containing the following explanation:

The wreck of the Lehigh Valley train at Manchester to-day was caused by a broken rail. The composition of the rail was according to the specifications of the company's experts, both chemists and engineers, and the rail was inspected with the usual care in process of manufacture and was subjected to the usual severe physical test after it was made. The rail was of the unusually high class for which a premium is paid.

The defect consisted of a "pipe," an air-hole, in the center of the web of the rail, extending for about 14 ins. The defect was such that it could not be detected by inspection. There were also hard spots about 1½ ins. in diameter in the ball of the rail in two different sections. The rail was made in December, 1909.

An inspector of the State Public Service Commission reached the scene shortly, and after an examination made a preliminary report which says in part:

Lehigh Valley train No. 4, consisting of 14 cars, left Rochester Junction 42 mins. late. Running through Manchester yards at about 25 mi. per hr., at a point about 600 ft. east of Manchester station it struck a broken rail which was broken into 17 pieces. The rail was "piped" and there were a number of growing defects on the ball of the rail. . . . No defects were discovered in the equipment of the train. Most of the people who were killed were in car 273 [the car which fell from the bridge], which was practically torn to pieces. This was a modern car, with full vestibules and steel platforms, and was lighted with gas and electricity. It folded up like a jackknife. The broken rail is held in control by the inspectors of the Commission. The rail expert of the Commission has been directed to go at once to Manchester and the service of one of the best rail experts in the country has been secured by the Commission. They will make a thorough examination.

The local coroner began an inquest into the causes of the fatalities on Aug. 28, in the presence of representatives of the Public Service Commission, the Interstate Commerce Commission and the railway company.

The rail which broke is said to have been of open-hearth metal, rolled after cropping 20% of the ingot. The railway's expert states that in his opinion the fracture was due not to the pipe but to flaws in the rail head.

A Head-on Collision between a mail train and a switching locomotive occurred on Aug. 21, near Minneapolis, Minn., on the Chicago, Milwaukee & St. Paul Ry. The mail train was some minutes late and the engineman of the switching locomotive ran on the track thinking the train had passed. But one person was injured.

A Passenger Train Was Derailed near Kirkwood, Ohio, on the Cincinnati, Hamilton & Dayton R. R. on Aug. 27. The train is reported to have been traveling at about 25 miles per hour when a defective rail threw the locomotive off the track. After running over the ties for some 300 yds., it was overturned. The engineman was seriously hurt, but the coaches did not overturn and no passenger was injured.

A Collision of a Passenger Train with a train of empty steel gondola cars on the Pittsburgh & Lake Erie R. R., at Pittsburgh, Pa., on Aug. 25, resulted in serious injuries to two passengers. In some manner, not yet accounted for, the train of gondolas backed through two open switches to the main line track just in time to collide with an excursion train which was rounding a curve in the opposite direction.

The Derailment of an Excursion Train on the Valley Division of the New York, New Haven & Hartford R. R., near Middletown, Conn., caused the death of one passenger and more or less serious injuries to a score or more of others on Aug. 27. The cause of the derailment is given as spreading rails. According to an official statement by the railway company every spike on the inner rail of a curve had been pulled out and the angle bars removed, and that an outer rail farther on the curve had also been tampered with. The railway company has offered a reward of $2,500 for the apprehension of the guilty parties. The coroner had not held an inquest at the time this note goes to press, but it is reported that an investigation by the chief of police of Middletown and a sheriff failed to convince them that the derailment had been caused by wreckers.

A Timber Truss Bridge Collapsed near Roseburg, Ore., on Aug. 24. The bridge crossed the Umpqua River, and, according to press reports, "was 332 ft. long and had but one span." It was built in 1891. Repairs were being made at the time of collapse, having been under way about three weeks. Five men of the repair gang were killed and four were seriously injured. The bridge is a total wreck.

The Cross-Country Flight of H. N. Atwood from St. Louis to New York City was completed on Aug. 25, the twelfth day. The first nine days' flying has been noted in previous issues. The tenth day was used for a short flight of 66 miles between Fort Plain and Castleton, N. Y., made in 1 hr., 32 min. The eleventh day's flight ended near Nyack, N. Y., being terminated here by engine troubles. However, 109 miles was covered in 2 hrs. 37 min. The last stage of 25 miles was made in 42 min. on the following day. The total time in the air was 28 hrs. 23 min.; 19 stops were made. This establishes a new record for distance (1,265 miles) of cross-country flight.

Lieut. Zolotnehin of the Russian Army was killed by the fall of his aeroplane flyer at St. Petersburg, Aug. 29.

A Grade Crossing Accident at Baldwin, Long Island, N. Y., resulted in the death of two persons on Aug. 19. An express train on the Long Island R. R. struck an automobile containing two passengers on a grade crossing, unprotected save by an alarm bell.

The Collapse of the Porter Ave. Pumping Station of the water-works of Buffalo, N. Y., on June 30 (Eng. News, July 6, 1911, p. 30; July 13, p. 56) has been under investigation in the City Court and Judge Hartzell of the Court, on August 25, handed down a decision charging the contractor on the steelwork, George P. Wurtz, and the architect, Robert A. Wallace, with criminal negligence. The two men were immediately arrested on the charge of manslaughter in the second degree and held for trial. The verdict finds that the concrete foundation wall had nothing to do with the collapse, that "the cause of the collapse was due to the omission in the roof purlins at the peaks of the trusses known as the A or main trusses, or the omission of sway or X-bracing in the roof of the building," that the contractor was responsible for these omissions and that the architect was responsible in that he did not insist on the placing of the purlins and bracing. The finding exonerates the local Department of Public Works on the ground that it deputed all of its supervisory power and duty to the architect.

A Hurricane swept over the coasts of Georgia and South Carolina on Aug. 27, destroying much property at Savannah, Charleston, Beaufort and other coast cities. The storm appears to have been worst at Charleston, S. C., where seven persons were killed and property damaged to the extent of about $1,000,000. The wind, it is reported, reached a velocity of 94 miles an hour, and blowing in with a high tide did much damage on the waterfront. All telegraph and telephone connections were cut off, and full details of the damage done were not available when this note was written.

A Panic in a Moving-Picture Theatre caused the deaths of 26 people at Canonsburg, Pa., on Aug. 26. It is reported that an electric fuse of the moving-picture machine burned out, causing a loud report. A cry of "Fire!" was raised, and a stampede was made for the exit. The main auditorium with seats for 1,000 people was on the second floor of the building, and was reached by a stairway said to be only 6½ ft. wide. This stairway became blocked and many were crushed to death in the mad struggle to escape from imaginary danger. The theater conditions, an up-stairs auditorium reached only by a narrow staircase, were much the same as in the case of the Boyertown, Pa., fire which occurred on Jan. 18, 1908, when nearly 200 lives were lost. After an investigation of the Canonsburg catastrophe the Deputy State Factory Inspector reported that the law had not been violated, that the fire escapes were in good condition, and that the stairway was as wide as the law required.

A Fire in a Copper Mine at the Giroux Consolidated Mines near Ely, Nev., cost the lives of six men on Aug. 24. According to reports the men, with four others, were at work on a 1,400-ft. level, when the shaft above was discovered to be in flames. All ten were hoisted as far as the 1,200-ft. level where they were stopped by the flames. Five left the hoisting cage, and attempted to make their escape to an old shaft, but were lost in the fire. The remaining five were hoisted through the burning shaft, and one was burned to death. The others were seriously injured.

A Powder Magazine Exploded at San Jose, Costa Rica, on Aug. 25. The magazine contained 98 cases of dynamite, 9,000 kilos of black and smokeless powder, and 1,300 caps. Five soldiers and ten civilians were killed. The cause of the explosion is said to have been a small charcoal furnace used by one of the soldiers to make lead images.

A Forest Fire in Newfoundland on Aug. 24-27 destroyed $2,000,000 worth of pulp wood, and threatened for a time to destroy the paper plant of the Albert E. Reed Co. at Bishop's Falls.

Fire Destroyed the Railway Shops of the Seaboard Air Line Ry. near Savannah, Ga., on Aug. 18. The plant consisted of a roundhouse, machine shop and boiler house. The shops were located just outside the city of Savannah and could not be reached from the city's water mains. The company had a private water-supply system which, however, did not prove sufficient. The loss is said to be $100,000.

A Roads Exhibit at the Ohio State Fair, Columbus, Ohio, Aug. 28 to Sept. 1, is to be held by the Ohio Good Roads Federation and the State Highway Department (Jas. R. Marker, Commissioner). Printed and other material for the exhibit may be sent to Roads Department. Vehicle Bldg., State Fair, Columbus, Ohio.

A Budget Exhibit will be held in New York City beginning Oct. 2. Three floors of the building at 330 Broadway will be used to display numerous charts, diagrams, models, moving pictures, etc.—all designed to show what New York City spends its money for and what returns are secured for the expenditure. It is hoped that material of the same general character relating to other cities will be brought to New York from the International Municipal Congress and Exposition, which is to be held in Chicago, Sept. 18 to 30. The New York Budget Exhibit is in the general charge of the Board of Estimate and Apportionment, and under the special direction of a Budgetary Publicity Committee with headquarters at 280 Broadway.

Instruction in First Aid to the Injured was given to 15,667 men by the Pennsylvania R. R. Co. during the past three years. The work is to be continued in the future, and invitations will be issued to local firemen and policemen in municipalities where the lectures are given to take advantage of the instruction. The lectures are given by the medical examiners of the relief department of the bureau.

Electrolysis of Water Pipes in Chicago is the subject of a report just issued by the Chicago Bureau of Public Efficiency. The investigations carried on under the Chief Engineer of the Bureau, Mr. A. S. Hammond, confirmed the fears of actual destruction of pipe and of the existence of zones of positive potential on the pipes above the railway tracks. In most places studied, where such positive potential existed, the actual readings

were less than one volt though in some cases it ran as high as five. The chief recommendation made by the Bureau was for a complete electrical survey to serve as the basis of mitigation work.

It is now announced that Mr. Ray Palmer, of Chicago, has been appointed by Mayor Harrison at a salary of $750 per month, including pay for such assistants as he needs, to investigate buried structures which may have been affected. Mr. B. J. Arnold, Chairman of the City's (street railway) Board of Supervising Engineers, has announced that this board has studied the prevention of electrolysis since its inception, and had secured on all new work such provisions as were possible to minimize the escape of current from rails. A sub-committee representing the Board of Supervising Engineers and each public utility of Chicago has been investigating and collecting data for three years, to be embodied as soon as possible in a formal report which is expected to lead toward a possible remedy for conditions which may exist.

The Retirement on Half Pay of 38 employees in the Public Works Department of Boston is reported. These men were employed in the paving, ferry and water divisions and include foremen, at $2,100 a year and less, an engineer, an inspector and minor employees.

Two Hoisting Magnets handled by traveling cranes at the plant of the Inland Steel Co., near Chicago, are said to have unloaded 2,000 tons of pig iron from a steamer in 10½ working hours, while with manual labor this work requires 28 men working two days and two nights. Only the two crane operators were employed, except that at the last a few men were employed to shift the pigs within reach of the magnets. It is stated also, that at the Homestead plant of the Carnegie Steel Co. two operators with electric traveling cranes equipped with hoisting magnets have done the work of handling pig iron and scrap that formerly required 25 men.

Personals.

Mr. J. Beaumont has been appointed Signal Engineer of the Chicago Great Western R. R.

Mr. R. T. Miller has been appointed Acting Manager of the Chicago office of the Pittsburgh Testing Laboratory, succeeding Mr. James A. Lister.

Sir William Whyte, Vice-President of the Canadian Pacific Ry., has retired from active railway work on account of his advanced age.

Mr. J. C. Bently, Assoc. M. Am. Soc. C. E., for the past six years Assistant Engineer of the New York, Ontario & Western R. R., at Middletown, N. Y., has resigned.

Mr. R. B. Burks has been appointed Acting Chief Engineer of Construction of the Chesapeake & Ohio Ry., with headquarters at Richmond, Va., succeeding Henry Pierce, M. Am. Soc. C. E., whose death is noted below.

Mr. James I. Tucker, for the past seven years an instructor at Tufts College, and recently Assistant Professor of Civil Engineering, has been appointed Adjunct Professor of Civil Engineering at the University of Oklahoma.

Mr. Cyrus A. Melick, formerly at the head of the department of civil engineering at Highland Park College, Des Moines, Iowa, has been appointed Assistant Professor of Civil Engineering at the Michigan State Agricultural College.

Messrs. W. F. Sloan, formerly Engineer, Testing Dept., Chicago Edison Co., Chicago, Ill., and W. J. Huddle have formed the firm Sloan, Huddle & Co., with offices in the Carroll Block, Madison, Wis., for the general practice of engineering, especially appraisals, examinations and reports.

Mr. Julius M. Bischoff, Assoc. M. Am. Soc. C. E., until recently Assistant Engineer in the Maintenance-of-Way Department of the Terminal R. R. Association of St. Louis, Mo., has been engaged as Engineer-in-Charge of the construction of a branch of the Cuban Central Rys. from San Juan de las Yeros to Cardosa, a distance of 25 kilometers.

Mr. G. B. Hegardt, M. Am. Soc. C. E., of Hegardt & Clarke, Portland, Ore., has been appointed Engineer of the Public Docks Commission of that city. Mr. Hegardt is a former member of the engineering staff of Corps of Engineers, U. S. A., and has had many years experience in river and harbor improvement work, including several years of work on the Columbia River jetty.

Mr. J. F. Russ, formerly Superintendent of the Northern Kansas division of the Missouri Pacific Ry. at Atchison, Kan., has been made Superintendent of the Omaha division at Falls City, Neb., succeeding Mr. A. De Bernadi, promoted. Mr. R. G. Carden, formerly Trainmaster at Jefferson City, Mo., has been promoted to Superintendent of the Northern Kansas division, succeeding Mr. Russ.

Mr. Gano Dunn, President, Am. Inst. E. E., for many years Vice-President and Chief Engineer of the Crocker-Wheeler Co., Ampere, N. J., has resigned to accept an important engineering and executive position elsewhere. Mr. Dunn leaves shortly for Europe to attend the Turin Exposition of the International Electrochemical Commission, of which he is to be President.

Mr. E. E. Allbee, for 21 years connected with the Safety Car Heating & Lighting Co., New York City, as draftsman, chief draftsman and mechanical engineer, has been appointed Mechanical Superintendent of the same. He will have charge of the development of all devices, including the bearing of patents on the same, and the distribution to the company's representatives of drawings and specifications for the installation and operation of all devices. He is also given general supervision of the drafting room.

Obituary.

Walter Hubbard, one of Connecticut's oldest and most prominent manufacturers, died after a short illness at the home of a friend in Burlington, Vt., on Aug. 24. He was 83 years old and one of the founders of the Bradley & Hubbard Mfg. Co., of Meriden, Conn.

Henry Pierce, M. Am. Soc. C. E., Chief Engineer of Construction of the Chesapeake & Ohio Ry., died at Clifton Springs, N. Y., on Aug. 21. He was born on June 7, 1859, at Quaker Hill, N. Y., and graduated from Cornell University in 1880. The following year he entered the employ of the Cincinnati & Southeastern Ry. as a levelman and draftsman. For a year he was a draftsman for the Cincinnati, New Orleans & Texas Pacific Ry., and for six years was with the Cincinnati, Hamilton & Dayton R. R. as draftsman, track supervisor and Engineer of Maintenance-of-Way. In March, 1889, he became Engineer of Maintenance-of-Way of the Western division of the Chesapeake & Ohio Ry. For three years, 1902 to 1905, he was Superintendent of the Greenbrier division; since then he has been Chief Engineer of Construction of the same road at Richmond, Va.

James Christie, M. Am. Soc. C. E., M. Am. Soc. M. E., died from apoplexy at his summer home at Atlantic City, N J., on Aug. 24. He was born in Ottawa, Ont., on Aug. 28, 1840. He was educated in the public schools of that city and came to Philadelphia when about 21 years of age, having previously worked in Detroit, Mich., as an apprentice, machinist and draftsman. In Philadelphia he was employed with the I. P. Morris Co. In 1865 he was in business for himself as a member of the firm of Butler & Christie. Later he was Superintendent of the Phillipsburg (N. J.) Mfg. Co., when Mr. Alfred P. Boller, M. Am. Soc. C. E., was Chief Engineer. From 1876 to 1905 he was associated with the Pencoyd Iron Works, and its successor, the American Bridge Co. Since 1905 he has carried on a consulting practice at Philadelphia, Pa. He was President of the Engineers Club of Philadelphia and a Vice-President of the Franklin Institute. A portrait of Mr. Christie will appear in a later issue.

Engineering Societies.

COMING MEETINGS.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 12-15. Annual meeting at St. Paul, Minn. Secy., Clarence R. George, Houston, Tex.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12-15. Annual convention at Atlantic City, N. J. Secy., A. P. Dane, Boston & Maine R. R., Reading, Mass.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION.
Sept. 12-15. Annual meeting at St. Louis, Mo. Secy., W. E. Emery, Peoria, Ill.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 13-15. Annual convention at Glenwood Springs, Colo. Secy., F. D. Morris, P. O. Box 1052, Colorado Springs, Colo.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 13-15. Annual convention at Gloucester, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN ASSOCIATION FOR LABOR LEGISLATION.
Sept. 15-16. Conference at Chicago, Ill. Secy., John B. Andrews, 1 Madison Ave., New York City.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 19-21. Annual convention at Spring Lake, N. J. Secy., N. T. Wilcox, Lowell, Mass.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Sept. 19-22. Annual convention at Milwaukee, Wis. Secy., James McFall, Roanoke, Va.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 21-23. Annual meeting at Toronto, Ont. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting at Kalamazoo, Mich. Secy., Julius Bordollo, Kingsbridge, New York City.

MICHIGAN GAS ASSOCIATION.
Sept. 20-22. Annual meeting at Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-27. Annual convention at Chicago, Ill. Secy., Preston S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 26-28. Annual convention at Grand Rapids, Mich. Secy., A. P. Folwell, 239 West 39th St., New York City.

AMERICAN MINING CONGRESS.
Sept. 26-29. Annual session at Chicago, Ill. Secy., J. F. Callbreath, Denver, Colo.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 10. Annual convention at Washington, D. C. Secy., Wm. H. Connolly, Washington, D. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 10-17. Annual convention at San Francisco, Cal., followed by trip to Japan. Secy., Joseph Struthers, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 10-12. Annual convention at Colorado Springs, Colo. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Annual convention at St. Louis, Mo. Secy., C. A. Lichty, C. & N. W. Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 18-20. Annual convention at St. Louis, Mo. Secy., A. B. Beadle, 29 West 39th St., New York City.

American Association for Labor Legislation.

A conference will be held under the auspices of this society at the Auditorium Hotel, Chicago, Ill., on Sept. 15 and 16. On Friday, Sept. 15, under Mr. Henry R. Seager, President of the Association as presiding officer, a discussion of "Standardization for Accident Prevention" will be held. Mr. John Calder, General Manager of the Remington Typewriter Co., will speak on "Scientific Accident Prevention"; Mr. Edgar T. Davis, Chief Inspector of Factories for the State of Illinois, will speak on "Safety Standards Through State Inspection," and Mr. Robt. J. Young, Safety Inspector of the Illinois Steel Co., will speak on "Practical Safety Devices." On Friday evening, Mr. Charles P. Neill, Commissioner, U. S. Bureau of Labor, will preside at a discussion on "Administration by Commissions." On Saturday forenoon Mr. John R. Commons, Member of the Wisconsin Industrial Commission, will preside at a discussion of "Uniform Reporting of Industrial Accidents." On Saturday afternoon conferences will be held on "Uniform Accident Reports," a continuation of the forenoon's discussion, for the purpose of drafting the schedule for uniform reports; on the "Administration of Workmen's Compensation Acts," by the Commissioners from various states, and a business meeting of the General Administrative Council of the Association for the discussion of an immediate legislative program, as follows: (1) Prohibition of poisonous phosphorus in the manufacture of matches; (2) Investigation of occupational diseases; (3) Reporting of industrial accidents and diseases; (4) Workmen's compensation for industrial injuries, and (5) Enforcement of labor laws. A special feature of all the sessions will be exhibits of photographs and charts illustrating the topics discussed.

American Peat Society.

The fifth annual meeting will be held at Kalamazoo, Mich., Sept. 21-23. Papers will be read describing the Canadian Government fuel plant at Alfred and a peat gas producer at Ottawa. At Kalamazoo a peat fuel plant in operation will be inspected. Dr. Joseph H. Pratt, Past President of the Society, will describe the work of draining 300,000 acres of swamp land in North Carolina. Mr. Carl Kleinstuck, Saxonia Farm, Kalamazoo, Mich., is Chairman of the Reception Committee.

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